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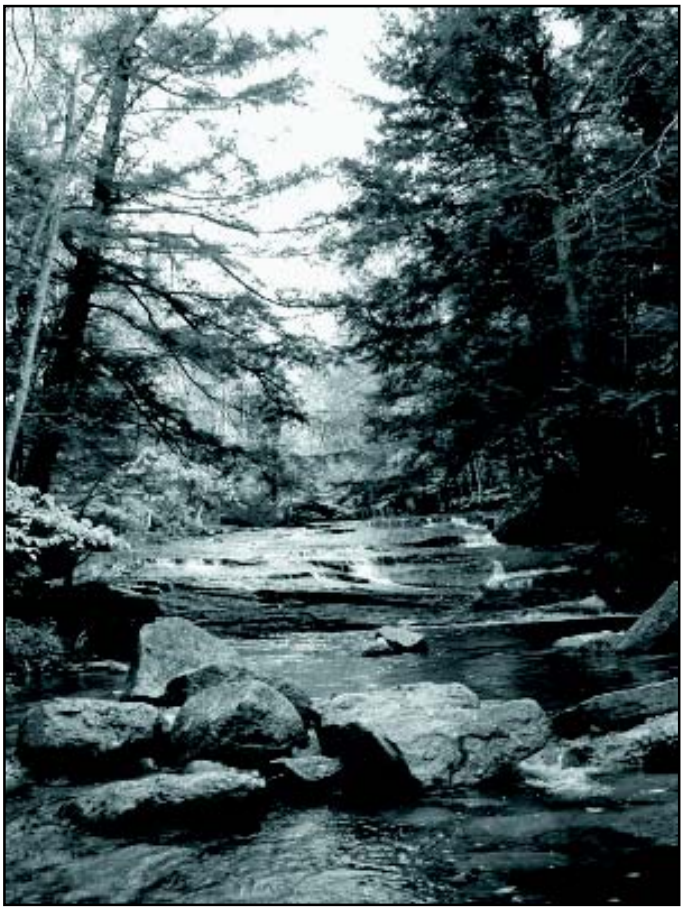
Sourcebook on Criteria and Indicators of Forest Sustainability in the Northeastern Area



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SOURCEBOOK ON CRITERIA AND INDICATORS OF FOREST SUSTAINABILITY IN THE NORTHEASTERN AREA

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Northeastern Area
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and

Northeastern Forest Resource Planners Association

In cooperation with:
Northeastern Area Association of State Foresters

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PREFACE

This sourcebook represents a collaborative effort between the USDA Forest Service, Northeastern Area, State and Private Forestry; the Northeastern Area Association of State Foresters; and the Northeastern Forest Resource Planners Association to address the issue of measuring forest sustainability. Forest Service and State resource professionals work to facilitate the collection, evaluation, and dissemination of information to foster the conservation and sustainable management of forest resources.

The **USDA Forest Service, Northeastern Area, State and Private Forestry (NA)**, commonly referred to as the Northeastern Area, is a unit of the Forest Service that serves the 20 States of the Northeast and Midwest, and the District of Columbia. It works in partnership with the State Foresters and State forestry agency staff to influence the wise management, protection, and sustainable use of rural to urban lands and to enhance the capacity of all forests to provide benefits for a growing America.

The **Northeastern Area Association of State Foresters (NAASF)** is a nonprofit organization that represents the directors of the State forestry agencies from each of the 20 States of the Northeast and Midwest, and the District of Columbia. It is one of three regional State Forester organizations that comprise the National Association of State Foresters and is committed to working with the Northeastern Area and others to provide better management, protection, and use of the forest lands they serve.

The **Northeastern Forest Resource Planners Association (NFRPA)** is a nonprofit organization that consists of the State forest resource planners from each of the 20 States of the Northeast and Midwest. It encourages and supports State forest resource planning programs and works to strengthen skills in planning and resource and policy analysis, while developing and maintaining a working relationship with the Northeastern Area Association of State Foresters, the Northeastern Area, and other organizations.

Figure 1. The Northeastern Area, Northeastern Area Association of State Foresters, and the Northeastern Forest Resource Planners Association serve the 20 States of the Northeast and Midwest. The Northeastern Area and Northeastern Area Association of State Foresters also serve the District of Columbia.

Connecticut
Delaware
Illinois
Indiana
Iowa
Maine
Maryland
Massachusetts
Michigan
Minnesota
Missouri
New Hampshire
New Jersey
New York
Ohio
Pennsylvania
Rhode Island
Vermont
West Virginia
Wisconsin

I. Introduction

Forest sustainability is a goal of many forestry organizations across the United States and throughout the world. Managing forests sustainably involves recognizing interconnections among ecological, social, and economic systems to preserve options for future generations while meeting the needs of the present. Sustainability, like many concepts, is difficult to define in concrete terms. Many organizations are turning to a *criteria and indicators* (C&I) approach to help describe forest sustainability. Under this approach, criteria define broad categories of sustainability and indicators are specific measurements of each category.

There are a host of efforts underway using C&I to describe forest sustainability. Notable among these is an effort commonly called the *Montreal Process*. This work is an outgrowth of the 1992 Earth Summit in Rio de Janeiro, Brazil. In 1995, the United States joined 11 other countries in signing a document establishing a set of 7 criteria and 67 indicators to track forest sustainability.

Both the Northeastern Area Association of State Foresters (NAASF) and the USDA Forest Service, Northeastern Area, State and Private Forestry (NA) (see Preface) endorsed the use of the Montreal Process C&I framework in efforts to achieve sustainability. They were concerned, however, about the potential for using the Montreal Process C&I at regional and State levels, particularly in regards to the applicability of the framework at these scales and the availability of data to support their use. At the request of NAASF, the Northeastern Forest Resource Planners Association (NFRPA) and NA formed a work group to address these issues in the 20 States of the Northeast and Midwest.

The NFRPA/NA C&I project work group developed this sourcebook, which outlines the basic use of criteria and indicators to assess forest sustainability by doing the following:

- Summarizes information on the development and use of forest sustainability C&I by organizations and agencies.
- Provides recommended resources for additional information on C&I.
- Presents a set of base indicators within the Montreal Process framework to assess the sustainability of forests across the region. These base indicators are recommended as a common set to be used by the Northeastern Area and as a starting point for the 20 State forestry agencies represented by NAASF.
- Describes a means to link State-sponsored and other C&I efforts to regional and national efforts.
- Presents lessons learned on the use, development, and implementation of criteria and indicators.

This sourcebook is meant to serve as a general source of information on criteria and indicators of forest sustainability. It is intended as a starting point for States and other organizations to help guide their efforts to use criteria and indicators for assessing forest sustainability.

II. Defining Forest Sustainability

Sustainability is an overarching goal and an extraordinary challenge for a diverse array of public and private organizations, agencies, and individuals. In forestry, it involves the continued existence and use of forests to meet human physical, economic, and social needs; the desire to preserve the health of forest ecosystems in perpetuity; and the ethical choice of preserving options for future generations while meeting the needs of the present.

Determining what is sustainable is a difficult task. It involves recognizing interconnections among ecological, social, and economic systems and competing views of acceptable tradeoffs among them. A framework of criteria and indicators of forest sustainability can be used to foster discussions on the meaning of sustainability for a particular time and place.

A. Criteria and Indicators

Sustainability criteria are goals or categories that reflect broad public values and recognized scientific principles. In the context of forest sustainability, the term ***criterion*** refers to a category of conditions or processes by which sustainable forest management may be assessed. A criterion is characterized by a set of related indicators that are monitored periodically to assess change (Canadian Forest Service 1995, Montreal Process Working Group 1999). Appropriately written criteria are value free, but should provide a good sense of the relative importance society places on the many values of forests. They capture a wide range of values about the forest, including ecological, social, and economic values.

An ***indicator*** is a measurement of an aspect of a criterion. It is a quantitative or qualitative variable that can be measured or described, and which, when observed periodically, demonstrates trends (Canadian Forest Service 1995, Montreal Process Working Group 1999). Thus, indicators are measurable or describable characteristics of a criterion that provide a means for tracking changes in ecological, social, and economic conditions affecting forests. Well-chosen indicators are directionless, but offer the opportunity to identify the present state, past trajectory, and future trends for a criterion. These characteristics allow us to follow the course of an indicator over time and make value judgments about whether the course is positive, negative, or neutral. In turn, indicators often have metrics or verifiers that refer to specific data or calculations, or describe the way that indicators are measured.

B. The Montreal Process

The United States has participated in an international effort to develop criteria and indicators for tracking progress in forest sustainability. This effort, called the Montreal Process, identifies a framework of criteria, subcriteria, and 67 associated indicators (appendix A). The criteria and subcriteria are listed in box 1.

What is remarkable about the Montreal Process framework is that 12 nations with a wide range of social, cultural, economic, political, and ecological conditions were able to achieve the following:

- Come to a common understanding of the contribution of forests to the well-being of people,

- Agree on the forest conditions and related processes that must be maintained for forested ecosystems to endure, and
- Articulate a common desire for legal, institutional, and economic systems that work toward sustainability.

*Box 1. The Montreal Process criteria and subcriteria (Montreal Process Working Group 1999)**

Criterion 1—Conservation of Biological Diversity

1.1 Ecosystem diversity
1.2 Species diversity
1.3 Genetic diversity

Criterion 2—Maintenance of Productive Capacity of Forest Ecosystems

Criterion 3—Maintenance of Forest Ecosystem Health and Vitality

Criterion 4—Conservation and Maintenance of Soil and Water Resources

Criterion 5—Maintenance of Forest Contribution to Global Carbon Cycles

Criterion 6—Maintenance and Enhancement of Long-term Multiple Socio-economic Benefits to Meet the Needs of Societies

6.1 Production and consumption
6.2 Recreation and tourism
6.3 Investment in the forest sector
6.4 Cultural, social, and spiritual needs and values
6.5 Employment and community needs

Criterion 7—Legal, Institutional, and Economic Framework for Forest Conservation and Sustainable Management

7.1 Extent to which the *legal framework* (laws, regulations, guidelines) supports the conservation and sustainable management of forests
7.2 Extent to which the *institutional framework* supports the conservation and sustainable management of forests
7.3 Extent to which the *economic framework* (economic policies and measures) supports the conservation and sustainable management of forests
7.4 Capacity to *measure and monitor* changes in the conservation and sustainable management of forests
7.5 Capacity to conduct and apply *research and development* aimed at improving forest management and delivery of forest goods and services

* No priority or order is implied in the numeric listing of the criteria.

Use of the Montreal Process framework of criteria and indicators is supported by the USDA Forest Service and the National Association of State Foresters as the primary model to guide forest sustainability assessment (NASF 1997, USDA Forest Service 1999). The first national assessment using this framework*, The First Approximation Report for Sustainable Forest Management: Report of the United States on the Criteria and Indicators for the Sustainable Management of Temperate and Boreal Forests,* was issued in 1997 (USDA Forest Service 1997). In addition, there are many ongoing public and private sustainability indicators efforts ranging from local to international scales. Some predate the development of the Montreal Process framework and others embed indicators similar to those used in the Montreal Process into broader frameworks to assess sustainable development and other concerns.

III. The Use of Criteria and Indicators by the Northeastern Area and the Northeastern Area Association of State Foresters

The USDA Forest Service, Northeastern Area, State and Private Forestry (NA) and the Northeastern Area Association of State Foresters (NAASF) share a commitment to the sustainable management of forests. Ideally, criteria and indicators (C&I) provide relatively complete, accurate, and unbiased information on forest conditions, the factors that influence forest conditions, and the way changes in forest conditions affect the benefits derived from forests. The Montreal Process framework of C&I has been endorsed by NA and NAASF as a useful tool for identifying the key ecological, social, and economic factors affecting the sustainable management of forests at multiple geographic scales and for structuring cooperative efforts to monitor and assess trends across political and administrative units (USDA Forest Service 1999).

NA and NAASF have committed to the long-term coordination and staffing of a forest sustainability information clearinghouse in close cooperation with the 20 State forestry agencies represented by NAASF. NA is also producing a C&I-based report on the status of forest health and sustainability in the 20-State region (box 2). In addition, NAASF commissioned a work group of Northeastern Forest Resource Planners Association (NFRPA) members and NA staff to help articulate the actions needed to implement C&I on an ongoing basis (appendix B). Key projects identified for the work group to date include (1) the compilation of information on the development and use of criteria and indicators, which has resulted in the production of this sourcebook; (2) the development of a limited number of indicators that can provide focus for State and cross-State collaboration in C&I data collection and reporting efforts, referred to as the base set of indicators or base indicators; and (3) an assessment of data availability and data gaps for the base indicators (appendix C).

The base indicators adopted by NAASF are targeted for NA-wide and State level assessment (box 3). They span the Montreal Process sustainability criteria and subcriteria, and link to information needs and issues common among the States.[1] The use of a consistent and coherent subset of Montreal Process indicators and associated metrics across State boundaries is intended to provide an important pathway for the flow of sustainability information at State, regional, and national levels. It also lays the groundwork for assessing

Box 2. Northeastern Area initial assessment of sustainability using the Montreal Process C&I

> The Northeastern Area has conducted an NA-wide assessment of sustainability using the Montreal Process C&I framework. The 67 Montreal Process indicators were addressed to the extent possible using readily available information from a variety of sources—Federal, State, and private inventory and monitoring programs, technical reports, journals, other publications, and public programs. The assessment builds on the base of information provided through the USDA Forest Service's Forest Inventory and Analysis and Forest Health Monitoring Programs and uses an ecologically based approach to assess forest conditions. The assessment has been used for NA strategic planning. It establishes a regional context for State and National forest planning, and, when published, will serve as a reference document on data availability and compatibility among the 20 States (USDA Forest Service 2001a).

[1] See appendix D for the process taken to develop these indicators.

*Box 3. This list of base indicators adopted by NAASF spans the Montreal Process criteria and subcriteria and is recommended for use in NA-wide and State forest sustainability assessments.**

Criterion 1—Conservation of Biological Diversity

Ecosystem Diversity

1. Area of forest land relative to nonforest land, area of timberland, and area of reserved land
2. Exent of area by forest type and by size class, age class, and successional stage
3. Degree of forest land conversion, fragmentation, and parcelization

Species Diversity

4. Status of species and communities of concern with focus on forest associated species

Criterion 2—Maintenance of Productive Capacity of Forest Ecosystems

5. Area of timberland
6. Annual removal of wood products compared to net growth

Criterion 3—Maintenance of Forest Ecosystem Health and Vitality

7. Area and percent of forest affected by damaging agents such as insects, disease, exotic/native species, fire, storm, land clearance, and domestic animals

Criterion 4—Conservation and Maintenance of Soil and Water Resources

8. Area and percent of forest land with significantly diminished soil organic matter, erosion, compaction, and/or changes in other soil chemical or physical properties
9. Area and percent of forest land adjacent to surface water and area of forested land by watershed
10. The condition and vulnerability of aquatic systems by watershed

Criterion 5—Maintenance of Forest Contribution to Global Carbon Cycles

11. Total forest ecosystem biomass and carbon pool, and contribution of forest ecosystems to the total carbon budget

Criterion 6—Maintenance and Enhancement of Long-term Multiple Socio-economic Benefits to Meet the Needs of Societies

Production and Consumption

12. Value and volume of wood and wood products production, consumption, imports, and exports

Recreation and Tourism

13. Outdoor recreation activities and use, recreational facilities and use

Investment in the Forest Sector

14. Public and private investments in forest health, management, processing, manufacturing, and research

* No priority or order is implied in the numeric listing of the criteria and indicators.

Box 3 (continued)

Cultural, Social, and Spiritual Needs and Values

15. Public, private, and industrial ownership and land use (including acres of specially designated land)

Employment and Community Needs

16. Trends in forest-related sectors' (e.g., wood products, recreation, and forest management) earnings and employment

Criterion 7—Legal, Institutional, and Economic Framework for Forest Conservation and Sustainable Management

Extent to Which the *Legal Framework* Supports the Conservation and Sustainable Management of Forests

17. Existence, type, and monitoring of voluntary or mandatory best management practices

Extent to Which the *Institutional Framework* Supports the Conservation and Sustainable Management of Forests

18. Existence, type, and frequency of forest-related planning, assessment, and policy review, including cross-sectoral planning and coordination

conditions in ecosystems and watersheds that span multiple States. In addition, these indicators can be incorporated into broader sets that encompass forest components, such as statewide sustainable development and environmental monitoring efforts.

An assessment conducted with this suite of base indicators can introduce the many facets of sustainability to the general public; can contribute to informed discussions of the appropriate balance among ecological, social, and economic considerations; and is a useful mechanism to track general information with regards to sustainability (e.g., by identifying agency performance measures linked to individual indicators). NAASF recommended that the base indicators be used to develop an NA-wide forest sustainability C&I assessment report every 5 years, at a minimum.

NA and NAASF continue to work on technical and organizational issues needed to fully utilize this set of base indicators. Probable metrics and data sources have been identified (appendix E), but further work is needed on common definitions, data availability, data currency, reliability, costs, reporting cycles, organizational roles, and partnerships.

As requested by NAASF, the NFRPA/NA C&I project work group surveyed individual States to determine which data from the base set of indicators, not already identified as available, are collected at the State level.[2] The work group has begun analysis of this information and is compiling it into a comprehensive availability assessment of the base indicators (including data available from all sources).

As part of their clearinghouse function, NA and NFRPA have compiled information on criteria and indicators. This information includes a database of 60 sustainability/indicators

[2] See appendix F for the process taken for the survey of data available at the State level.

projects, as well as a database of actual indicator sets for 39 projects. These databases were used in the development of this sourcebook and are available by request.[3]

This report and other sustainability-related information and Web links are available on the Northeastern Area's Sustainability Program Web site (http://www.na.fs.fed.us/sustainability/). As the data are assembled, it is anticipated that data on the base indicators for the 20 States and the region as a whole will also be posted on this Web site.

[3] To request a copy of the database(s), please contact Sherri Wormstead, NA Sustainability Program Assistant, at swormstead@fs.fed.us or 603-868-7737 or access additional information on-line at http://www.na.fs.fed.us/sustainability/.

IV. Evaluation of Existing Sustainability/Indicators Projects

In cooperation with the Northeastern Forest Resource Planners Association (NFRPA), the USDA Forest Service Northeastern Area Sustainability Program evaluated 60 sustainability/indicators efforts being implemented across the nation, including many across the 20 States served by the Northeastern Area. While there are more efforts that could have been included, this summary provides valuable information for agencies and organizations interested in developing and using criteria and indicators of sustainability. It includes information such as who is involved in these efforts, the level of public involvement, and sources of further information. These efforts vary in type, scale, motivation, and in many other ways. The efforts considered include the following:

- Initiatives that are still in the process of securing funding to established projects that have continual funding
- Projects spearheaded by government agencies (local, State, and national), nongovernment organizations, and citizens
- Efforts with only one agency or organization involved to those with multiple stakeholder involvement
- Efforts with and without public involvement
- Long-term monitoring projects as well as short-term research projects
- Initiatives with participants from one sector to wide-scale initiatives with multidisciplinary and stakeholder involvement

Thirty-nine of the projects had developed indicators, which were studied further and analyzed in comparison to the Montreal Process C&I framework. The review included similarities and differences in definitions among projects, the variety of hierarchical structures adopted by various efforts, the most and least common indicators used, and existing linkages to the Montreal Process C&I.

A. Analysis of Sustainability Efforts

A wide range of information was compiled and analyzed for the 60 different sustainability/indicators efforts. As presented below, key pieces of information include effort type, geopolitical scale, who is involved, reasons/motivation, goals and vision, steps taken, relationship of the effort to the Montreal Process C&I, effort timeframe, indicators used, and definitions of key terms.

For the purpose of this analysis, an "effort" was defined broadly. The efforts address forest sustainability, sustainable development, or environmental/ecological indicators. Efforts of every geopolitical scale were considered, including international, national, regional, State, and local. However, for the regional, State, and local scale efforts, emphasis was placed on those occurring within the 20-State region.

Effort Type

Each effort was categorized according to the overall focus, or type, as follows:

Forest Sustainability—Includes efforts focused on forest sustainability, with or without the development of indicators (e.g., *Sustaining Penn's Woods*).

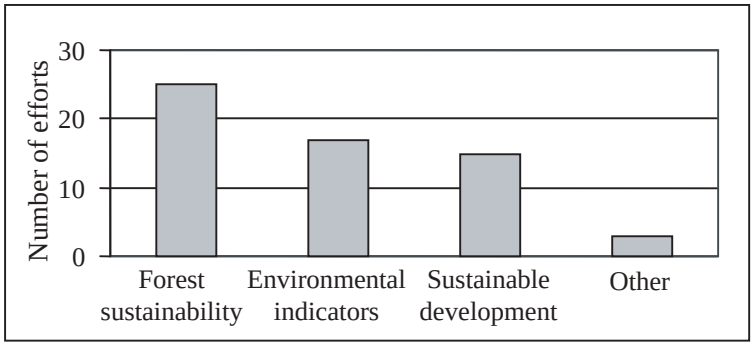
Environmental/Ecological Indicators—Includes efforts focused on environmental or ecological indicators (e.g., *Minnesota's Environmental Indicators Initiative)*. Although forestry is often included as a component, it is not the main focus or motivation of the effort.

Sustainable Development Indicators—Includes efforts focused on community sustainability indicators (e.g., *Sustainable Boston*). Although forestry may be included as a component, it is not the main focus or motivation of the effort.

Other—Includes other efforts that address sustainability/indicators, but do not fit into the above categories (e.g., *Missouri Resource Assessment Partnership*, a natural resource monitoring effort).

Of the efforts analyzed, 25, or just over 40 percent, are forest sustainability efforts, with the remaining entries roughly split between environmental/ecological and sustainable development indicators efforts (figure 2).

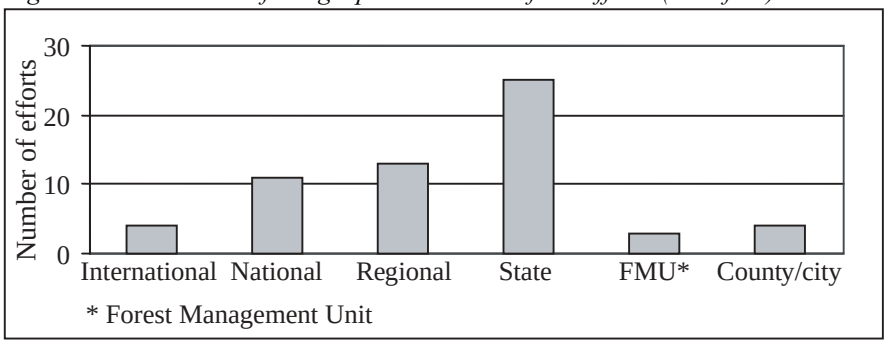
Figure 2. Distribution of the type of efforts (out of 60)



Geopolitical Scale

The geopolitical scale of the efforts analyzed here includes international, national, regional (multistate), State, county/city, and forest management unit scales (figure 3). The State scale accounted for the most efforts, with 25 efforts, or just over 40 percent, at that scale. Thus for many States, there is an existing C&I sustainability network to connect to. The next two highest categories are rather evenly split between national and regional scales, with roughly 20 percent of all efforts in the database at each scale. Small numbers of efforts (3 or 4) were focused at each of the remaining scales: international, Forest Management Unit, and county/city.

Figure 3. Distribution of the geopolitical scale of the efforts (out of 60)



Relationship to the Montreal Process Criteria and Indicators

To consider to what extent the efforts were connected with the Montreal Process C&I, each one was categorized according to its use of or connection to the Montreal Process. The following categories were used:

Independent Of—Montreal Process C&I were not cited or considered.

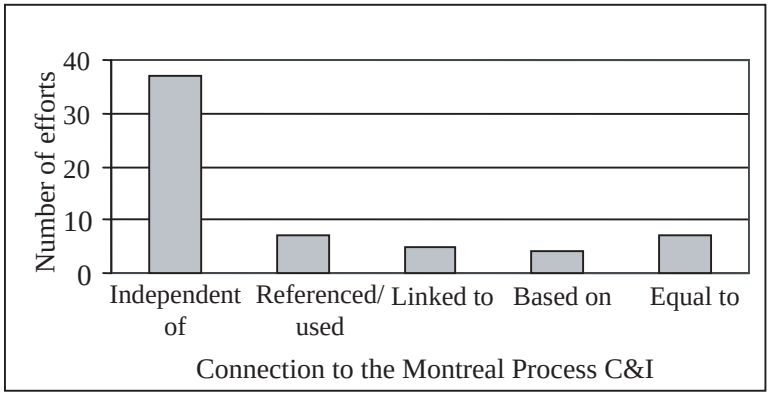
Referenced/Used—Montreal Process C&I were cited in a report, or at least considered.

Linked To—Although not the primary basis of their work, the Montreal Process C&I are explicitly linked to the effort's own criteria and indicators.

Based On—The core work of the effort is based on the Montreal Process C&I. The effort C&I are adapted from the Montreal Process C&I.

Equal To—The effort is direct Montreal Process C&I work, integrated as part of implementation of the Montreal Process C&I (figure 4).

Figure 4. Connection of the efforts to the Montreal Process C&I (out of 60)



Well over half of the efforts were conducted independently of the Montreal Process, that is, the Montreal Process C&I were not considered or cited (e.g., *New England Goals and Indicators Project/ Partnership)*. The rest of the efforts at least cited or used the Montreal Process to some extent. Almost 20 percent of the efforts were based on or were direct Montreal Process work. The following efforts are direct Montreal Process implementation work:

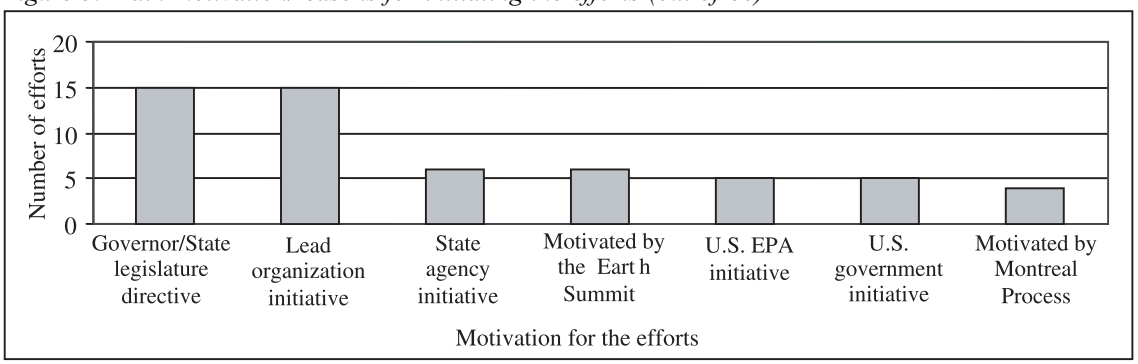
- Forest Sustainability Assessment Report for the Northern United States
- Illinois Report on Sustainable Forest Management
- Montreal Process Working Group
- NAASF First Approximation Assessment Project
- National Association of State Foresters Sustainable Forestry Implementation Committee
- U.S. First Approximation Report
- U.S. Roundtable on Sustainable Forests

Motivation/Reasons for Initiating the Efforts

To the extent available, descriptions as to why the effort was initiated were analyzed, including what motivating factors or reasons lead to the effort. Among the main reasons or motivation for the efforts, the top two, each with a quarter of the efforts, were (1) governor or State legislature initiatives, statutes, or mandates (e.g., the *Maine Forest Sustainability*

Standards was State legislature directed) and (2) initiatives of the lead organization, that is, the effort is closely aligned with the organization's mission and objectives (e.g., the American Forest & Paper Association *Sustainable Forestry Initiative Program)* (figure 5). Additional reasons or motivations cited repeatedly include State agency initiatives (e.g., Maryland Department of Natural Resources *Strategic Forest Lands Assessment),* efforts as a result of the United Nations Conference on the Environment and Development (e.g., *The World Commission on Forests and Sustainable Development)*, U.S. Environmental Protection Agency initiatives (e.g., *National Environmental Performance Partnership System),* Montreal Process implementation (e.g., *National Association of State Foresters First Approximation Report)*, and other U.S. Government initiatives (e.g., *U.S. Interagency Working Group on Sustainable Development Indicators).*

Figure 5. Main motivation/reasons for initiating the efforts (out of 60)



Who Is Involved

A wide variety of agencies, organizations, and other stakeholders were involved across the 60 efforts. Participants or categories of participants most often involved include the USDA Forest Service, State environmental/natural resource agencies, State forestry agencies, the U.S. Environmental Protection Agency, and universities (including ecologists, forest economists, and forest sociologists) (table 1). Each of these participants were involved in at least 20 percent of the efforts. Other participants involved in multiple efforts include State planning offices, The Nature Conservancy, the U.S. Geological Survey, funding foundations, the U.S. Fish and Wildlife Service, the USDA Natural Resources Conservation

Table 1. Participants most often involved in the efforts

Participant	No. of efforts
State environmental agencies and departments of natural resources	31
U.S. Environmental Protection Agency	23
USDA Forest Service	21
Universities	17
State forestry agencies	14
State planning offices	9
The Nature Conservancy	7
U.S. Geological Survey	7
Foundations (e.g., the MacArthur Foundation)	6
U.S. Fish and Wildlife Service	6
USDA Natural Resources Conservation Service	6
U.S. Department of the Interior (Bureau of Land Management 3 out of 6)	6
National Association of State Foresters	4

Service, and the National Association of State Foresters. In addition, numerous State and local agencies, organizations, and businesses were involved in many of the efforts.

Public Involvement

The public was involved to some extent in over half of the sustainability/indicators efforts. Many of these efforts involved the public in more than just public review and feedback on project reports. Some held informative workshops and elicited feedback during listening sessions. Other efforts requested feedback on draft indicators. A few efforts even involved citizen networks in data collection.

The extent to which the public was involved varied widely and was categorized on a scale from not involved to extensively involved:

Not Involved—The public was not involved in the effort.

Minimally Involved—The public was involved minimally in activities such as review of final reports.

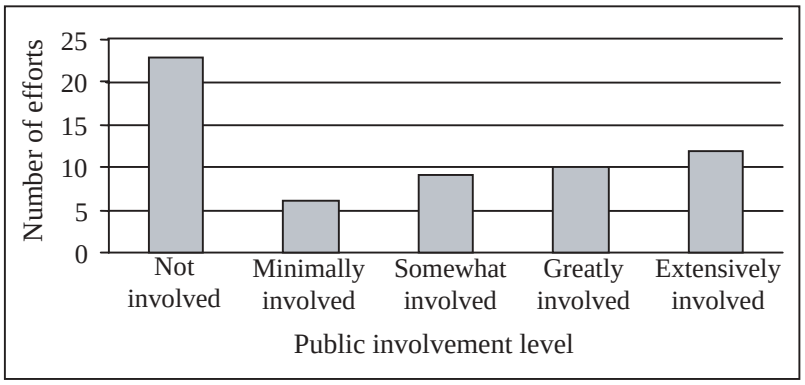
Somewhat Involved—The public was involved beyond the minimal level in activities such as providing input on draft reports.

Greatly Involved—The public was involved to a greater extent in activities such as workshops, listening sessions, and review of draft indicators.

Extensively Involved—The public was extensively involved and engaged throughout the process in activities such as workshops, development of the indicators, and data collection (figure 6).

The public was not involved in 23 of the efforts; however, they were involved to some extent in 37, or over half, of the efforts. Citizens were greatly to extensively involved in 22 efforts.

Figure 6. Public involvement in the efforts (out of 60)



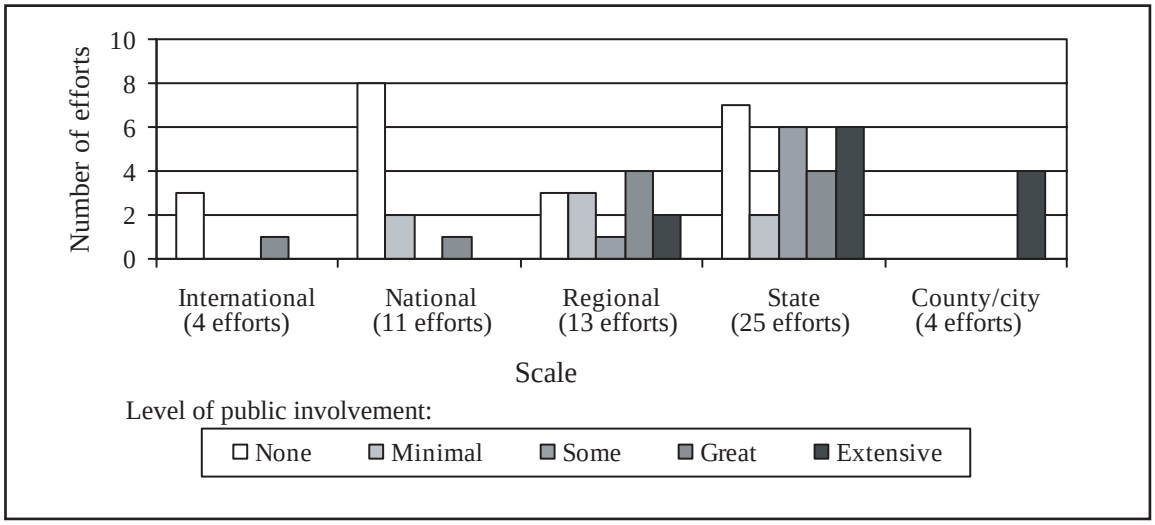
The following list provides specific examples of public involvement:

- The *minimally involved* level—The *U.S. Working Group on Sustainable Development Indicators* requested public comment on its report.
- The *somewhat involved* level—The *Maryland Environmental Indicators* effort involved the public in revision of draft indicator reports.
- The *greatly involved* level—The *Sustaining Penn's Woods* effort held a series of 15 public meetings across the State and facilitated on-line comment on the draft indicator framework.

- The *extensively involved* level—The *Sustainable Boston* effort held over eight major citywide events and involved the public in sustainability discussions, evaluation of the indicators, data collection, and review of reports.

Public involvement also varied by the scale of the efforts, with more extensive public involvement occurring in local efforts then in efforts at other scales (figure 7). At the international scale, 3 out of the 4 efforts had no public involvement; at the national scale, 8 out 11 efforts had no public involvement. At the regional and State scales, the level of public involvement varied. However, at the county/city scale, all of the four efforts had extensive public involvement.

Figure 7. Public involvement varied by effort scale, with more involvement in efforts at smaller scales.

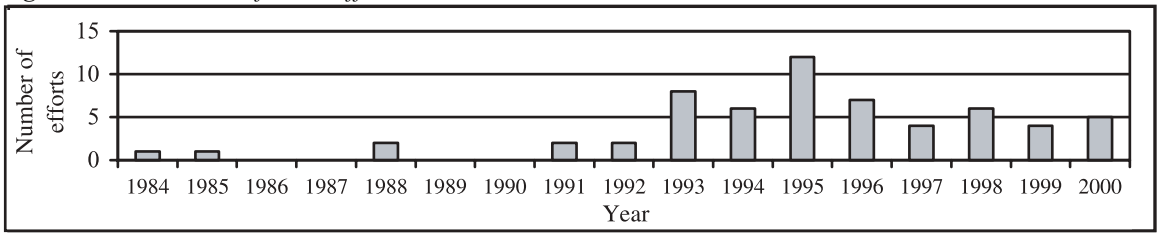


Effort Timeframe

Timeframe for the efforts was analyzed, including what year the effort began (figure 8) and, where relevant, what year the effort ended. It was also noted which efforts are ongoing.

A majority of efforts were started in 1995 or later. In fact, 12 of the efforts began in 1995. Figure 8 does not necessarily represent how long the efforts have been active—for example, an effort that began in 1988 may have ended 5 years later. The age of the efforts varies greatly. All but two of the efforts (*Narragansett Bay Estuary Program* and *Chesapeake Bay Program)* were fewer than 11 years old. Most of the efforts were 6 or fewer years old, with almost 40 percent only 1 to 3 years old. Ongoing efforts are those for which there is no specific end date. For example, the *Sustainable Forestry Partnership* is a

Figure 8. Distribution of when efforts were started



continual process (ongoing), whereas the *President's Council on Sustainable Development* was a 6-year project that has ended (not ongoing). Over half of the efforts are ongoing.

B. Analysis of Sustainability/Environmental Indicators

Thirty-nine of the 60 sustainability/indicators efforts evaluated had developed a set of indicators; therefore, the following analysis is based upon indicators from those 39 efforts.

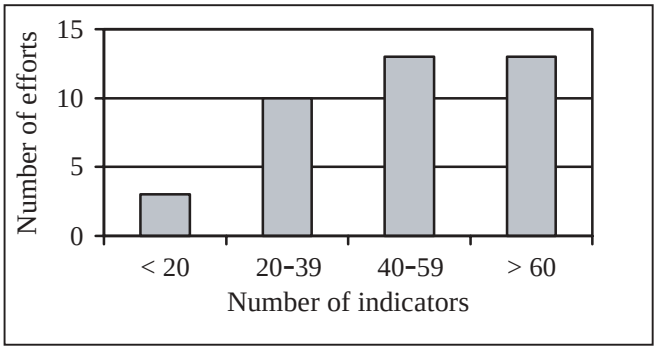
Comparison of Indicators by Effort Type

Sustainable development efforts often include indicators for social and economic sectors not considered in forest sustainability efforts. For example, *Sustainable Boston* has a section addressing "civic health" with indicators such as "universal access to health care." On the other hand, ecosystem indicators efforts often include additional ecological indicators not considered in forest sustainability efforts. For example, the Heinz Center *Report on the State of the Nation's Ecosystems* has a section on "croplands" with indicators such as "average size of farm fields." It is natural that indicator sets would vary depending upon the purpose for which they are developed. Clearly identifying the purpose for indicators early in the process is key for the development of indicators appropriate for the particular purposes and uses desired.

Number of Indicators

The number of indicators per effort is highly variable and depends upon the scope of the project. Overall, the number of indicators used by each effort ranged from 12 to 216 (figure 9). Only 3 efforts had fewer than 20 indicators. Ten efforts had 20–39 indicators, 13 efforts had 40–59 indicators, and 13 efforts had over 60 indicators.

Figure 9. The number of indicators used (for 39 efforts)



Overall, the average number of indicators used by forest sustainability efforts was 60. Complete indicator sets for forest sustainability projects ranged from 23 to 170 indicators (table 2). For many of these efforts, the indicators were developed through a comprehensive and iterative process, beginning with a large list and narrowing it to a workable number. The *Great Lakes Forest Alliance Sustainable Forest Management C&I Project* is an example of this process. Beginning with a list of over 150 indicators, participants spent over 2 years on an iterative process of technical review and public input to carefully narrow the number of indicators while maintaining the important aspects of sustainability (Hinrichs-Sanders 2000). The final set of indicators contains 33 indicators evenly distributed among ecological, social, and economic "pillars."

*Table 2. The number of indicators used by forest sustainability efforts varies from 23 to 170.**

Forest sustainability effort	Number of indicators
Forest Stewardship Council (FSC)	170
Great Lakes Forest Alliance Sustainable Forest Management C&I Project	33
Lake Superior State Forest Sustainable Forest Management Project	77
Local Unit Criteria & Indicators Development Project (LUCID core indicators)	42
Montreal Process C&I	67
North American Test of C&I of Sustainable Forestry	57
Oregon Forest Assessment Projects	23
Sustainable Forestry Initiative (SFI) Program	35
Sustaining Penn's Woods	79
Vermont Forest Resources Plan	26
Wisconsin Northern State Forest Assessments	54

*The Maine Forest Sustainability Standards is not included in this table because indicators have not been developed for all the criteria.

Hierarchical Structure

In almost all of the indicator sets developed and used by the 39 efforts, there were hierarchical levels used to structure the sustainability/environmental assessments. The Tropenbos Foundation recommends the use of "a set of principles, criteria, and indicators, or at least some combinations of these hierarchical levels, that serves as a tool to promote [sustainable forest management], as a basis for monitoring and reporting or as a reference for assessment of actual forest management," further stating that, "An unambiguous and well explained hierarchical framework is a prerequisite for a coherent and consistent [framework]" (Lammerts van Bueren and Blom 1997, p. 11). The Montreal Process utilizes a hierarchical framework with two levels: the 7 *criteria* and 67 underlying *indicators.*

The indicator set framework used by each effort varied somewhat (table 3). A majority of the efforts used either two (e.g., *criteria* and *indicators*) or three (e.g., *principles, criteria,* and *indicators*) hierarchical levels. Examples include the *Lake Superior Lakewide Management Plan* framework of criteria and indicators and the *North American Test of C&I of Sustainable Forestry* framework of principles, criteria, and indicators. Three of the efforts had four hierarchical levels (e.g., the Heinz Center *Report on the State of the Nation's Ecosystems* framework has *ecosystems, system aspects, ecosystem properties,* and *measures)*. In addition, two of the efforts listed the indicators without a hierarchical framework (e.g., *Sustainable Lansing Project* had a list of indicators that was not organized into categories). The large number of independently generated criteria and indicators efforts is a testament to the utility of this concept for guiding sustainability monitoring and assessment activities.

Table 3. Range of hierarchical levels used and examples (out of 39 sets of indicators)

Number of hierarchical levels	Number of efforts	Example structure/terminology	
4	3	Ecosystems ▼ System aspects ▼ Ecosystem properties ▼ Measures	Programs ▼ Goals ▼ Objectives ▼ Indicators
3	16	Principles ▼ Criteria ▼ Indicators	Criteria ▼ Indicators ▼ Benchmarks
2	18	Criteria ▼ Indicators	Goals ▼ Indicators
1	2	Indicators (not hierarchical)	

Definitions

Overall, most of the frameworks used by the efforts consist of at least *criteria* and *indicators*. As defined earlier, a *criterion* is a category of conditions or processes by which sustainable forest management may be assessed, and an *indicator* is a quantitative or qualitative parameter that can be assessed in relation to a criterion. Although this concept of broad categories of conditions or processes (criteria) with specific parameters that can be assessed in relationship to the categories (indicators) was evident throughout all but two of the efforts, the terms criteria and indicators were not always used. For instance, in several cases, instead of using the term criterion, efforts used terms such as *category*, *objective*, or *goal area.* Other efforts used the term *measure* in place of indicator. For example, the *Sustainable Boston* effort uses a framework of *sections, indicators,* and *measures,* where the indicators are short, criterion-like statements such as "healthy ecosystems" and measures are specific indicator-type parameters such as "acres of protected wetlands" (The Boston Foundation 2000).

In some cases, *proxy indicators* were used as a solution to account for the lack of ideal data available at the present time. In the iterative process of indicator development, the intention is for the proxy indicator to be used until a more adequate indicator can be developed. For example, the *Maine Forest Sustainability Standards* included proxy indicators in place of indicators in some places throughout their criteria, indicators, and benchmarks framework (Maine Forest Service 1999).

Tiers of Indicators

Tiering of indicators was used in different ways by a few of the efforts. Tiering is used by the Oregon Department of Forestry to utilize indicators for different purposes. They present the following three tiers of indicators (Oregon Department of Forestry 2000b):

- *Tier 3*—The full suite of Montreal Process indicators with the hierarchical framework of 7 criteria and 67 indicators
- *Tier 2*—A set of 23 core indicators, structured according to the Montreal Process criteria, intended to provide the Board of Forestry and other policy makers with a comprehensive system of indicators that describe environmental, social, and economic conditions
- *Tier 1*—A small set of 3 to 4 indicators contributing to the larger, multiagency *Oregon Benchmarks* to provide the general public with a "bird's-eye" view, or first point of contact, to understand forest conditions

In this example, all of the tier 1 indicators are contained in the tier 2 set and all of the tier 2 indicators are contained within the full tier 3 set.

Prioritizing Indicators

A few efforts prioritized their full list of indicators and then narrowed the list to a measurable set. The *New England Environmental Goals and Indicators Project* used this process and prioritized its long list of indicators according to the following four levels (Green Mountain Institute for Environmental Democracy 1996):

- *Level 1*—Indicators that meet the criteria regarding the indicator quality, as well as (a) have direct links to program activities and (b) would not require additional resources to collect and report the data supporting them
- *Level 2*—Indicators that do not meet the criteria for the Level 1 but are a high priority for further development because (a) they could potentially be moved into Level 1 with some rewording and/or clarification, (b) the indicators (and the issues they reflect) are of significant importance, and/or (c) they are in use or could be used by some but not all of the six States and the U.S. EPA's New England Region
- *Level 3*—All other indicators worth further consideration
- *Level 4*—Those indicators not worth pursuing further at this time (in their current form)

This prioritization enabled the project to identify the indicators they could begin reporting on without losing sight of other important indicators that were not easily measurable at the time.

Benchmarks

Qualitative or quantitative reference values or conditions are commonly called benchmarks. Bridge and others (2002) observed: "Some consider benchmarks to be an essential part of an indicator system, either by helping to place the indicator in context so that it can be understood by non-technical audiences, or by providing a reference condition against which changes in the indicator can be measured and assessed" (p. 4).

Benchmarks have been defined and used in different ways. Targets, milestones, and reference values have all been used as a form of benchmark. For example, the *Maine Sustainability Standards* defined benchmarks as "intermediate objectives for attaining goals" (Maine Forest Service 1999, p. 36). However, instead of benchmarks, the *Lake Superior State Forest Sustainable Forest Management Project* uses *targets*, defined as, "the desired level to be achieved by an indicator" (Hayes and others 1999, p. 3). The *Oregon Assessment Projects* are working on what they call *reference values* for their indicators.

Out of the 39 efforts with indicators, only 6 had developed benchmark-type statements. They range from broad qualitative, directional statements such as "reduced rate of agricultural and forest land conversions to non-resource use" (Maryland Department of the Environment 1999, p. 65), to quantitative, time-oriented statements such as "the amount of conservation land intended for public use will improve by 10 percent, from 957,622 acres in 1993 to 1,053,400 acres by at least 2000" (Maine Development Foundation 2000, p. 22). An additional four efforts were working on or planned to develop benchmarks.

Among the forest sustainability efforts, one had developed benchmarks *(Maine Sustainability Standards)* and an additional three were working on or planned to develop benchmarks *(Lake Superior State Forest Sustainable Forest Management Project, Local Unit Criteria and Indicators Project,* and *Oregon Forest Assessment Projects)*. In addition, two of the forest sustainability efforts are certification programs: the *Forest Stewardship Council* has regional indicators with verifiers, and the *Sustainable Forestry Initiative* has *performance measures* in place of indicators, which serve as "standards."

Comparison of Indicators to the Montreal Process Criteria and Indicators

Indicators from 28 efforts were compared to indicators from the Montreal Process framework (box 4). Only the relevant sections of indicators were compared for programs that included sections of indicators beyond the scope of the Montreal Process criteria, for example, "toxic chemical management." Consequently, for 12 of the efforts, the whole sets of indicators were compared to the Montreal Process criteria and indicators, and for 16 of the efforts, only select indicators were compared.

Comparison of Indicators to the Montreal Process Criteria

Most of the programs had indicators that link to the Montreal Process criteria dealing with the conservation of biological diversity (criterion 1), maintenance of forest ecosystem health and vitality (criterion 3), conservation and maintenance of soil and water resources (criterion 4), and maintenance and enhancement of long-term multiple socio-economic benefits (criterion 6). In addition, over half of the programs had indicators related to the Montreal Process criteria dealing with maintenance of productive capacity of forest ecosystems (criterion 2) and the legal, institutional, and economic framework for forest conservation and sustainable management (criterion 7). Only five programs had indicators comparable to the Montreal Process criterion addressing the maintenance of forest contribution to global carbon cycles (criterion 5).

Box 4. Indicators from the following 28 efforts were compared to the Montreal Process C&I.

- Ecosystem Indicators and Targets for Lake Superior
- Forest Stewardship Council
- Great Lakes Forest Alliance Sustainable Forest Management C&I Project
- Illinois Critical Trends Assessment
- Lake Superior State Forest Sustainable Forest Management Project
- Local Unit Criteria & Indicators Development Project
- Maine Forest Sustainability Standards
- Maryland's Environmental Indicators/ Performance Partnership Agreement
- Mid-Atlantic Integrated Assessment
- Minnesota Environmental Indicators Initiative
- New England Goals and Indicators Project/ Partnership
- New Jersey Future
- New Jersey Environmental Indicators and Performance Partnership Agreement
- North American Test of C&I of Sustainable Forestry
- Northern Forest Wealth Index
- Ohio Comparative Risk Project
- Oregon Forest Assessment Projects
- President's Council on Sustainable Development
- Report on the State of the Nation's Ecosystems
- Selection of Indicators for Great Lakes Basin Ecosystem
- Sustainable Boston
- Sustainable Forestry Initiative Program
- Sustaining Penn's Woods
- Trends in Sustainability Indicators Project
- U.S. Interagency Working Group on Sustainable Development
- Vermont Forest Resources Plan
- Vermont Strategic Plan and Agency of Natural Resources Indicators
- Wisconsin Northern State Forest Assessments

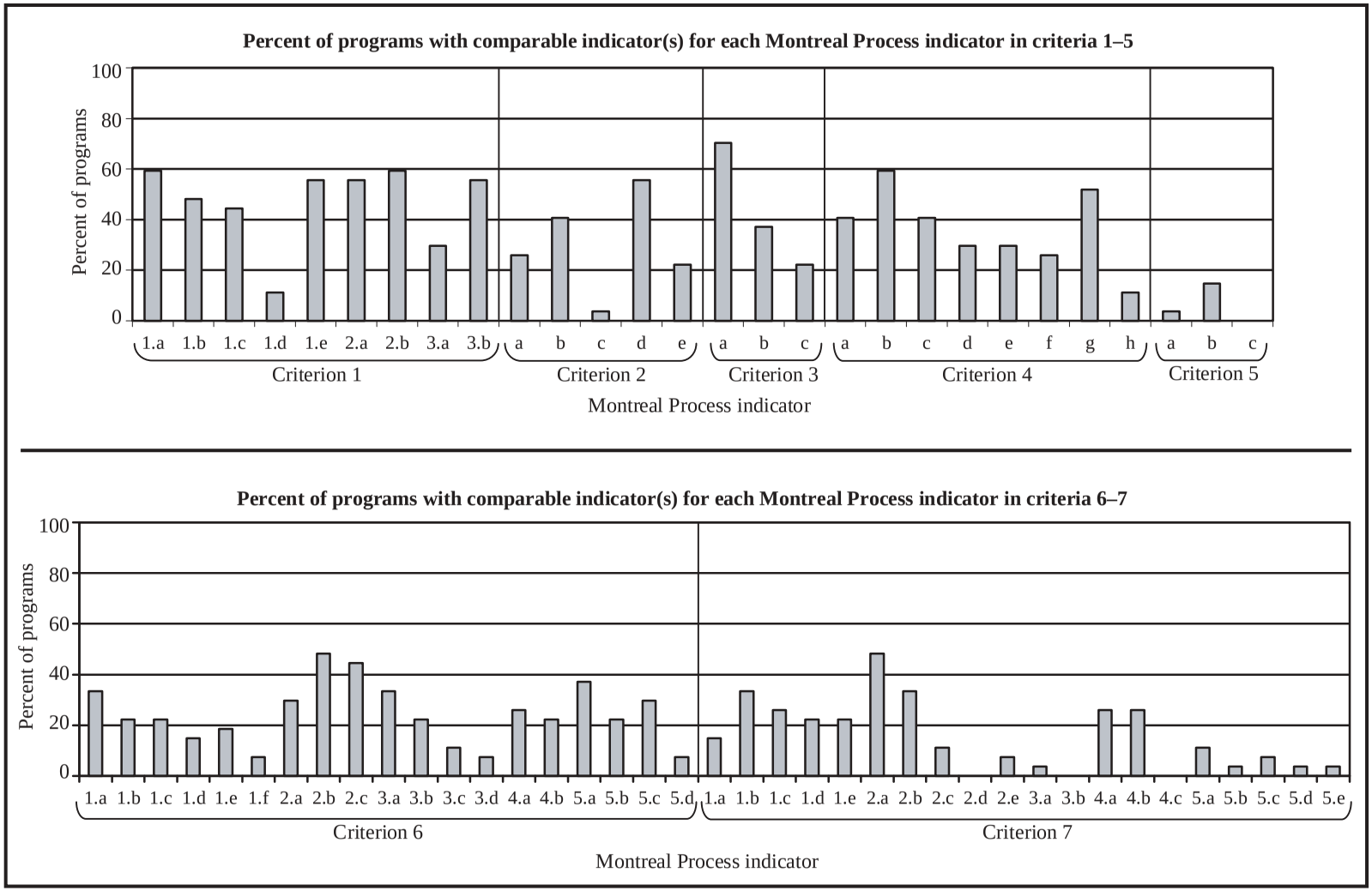
Comparison of Indicators to the Montreal Process Indicators

The percentage of programs with indicators that are comparable to the Montreal Process indicators varied (figure 10). Nine Montreal Process indicators had over 50 percent of the programs with comparable indicators, 19 had 30–49 percent of programs with comparable indicators, 23 had 10–39 percent of programs with comparable indicators, and 16 had fewer than 10 percent of programs with comparable indicators.

The Montreal Process indicators that had the highest number of programs with comparable indicators (at least 13 programs each) are not evenly distributed across the Montreal Process criteria (box 5). Of these 12 indicators, 6 are in criterion 1 (conservation of biological diversity) and 2 are in criterion 4 (conservation and maintenance of soil and water resources). There is one indicator each in criteria 2, 3, 6, and 7, and none in criterion 5.

In all, over 1,000 individual indicators from 28 different efforts were compared to the Montreal Process C&I. One third of these indicators did not fit well into the Montreal Process C&I framework. Overall, there was not a lot of commonality among those indicators; however, there are some categories of indicators that were used by more than one effort. Four of these categories are *land ownership* indicators, such as "percent of land owned by ownership types," *land use types* indicators, such as "conversion of cropland to other uses," *wetlands* indicators, such as "acres of wetlands lost (or gained)," and *potential nutrient loading* indicators, such as "area treated with herbicides, pesticides, fertilizer" (table 4). Although these indicators may be linked to one or more Montreal Process indicators, they are not explicitly addressed in the Montreal Process indicator wording.

Figure 10. Percent of programs with comparable indicator(s) for each Montreal Process indicator (out of 28 programs). For example, 59 percent of programs had at least one indicator comparable to Montreal Process indicator 1.1a*


Percent of programs with comparable indicator(s) for each Montreal Process indicator in criteria 1–5
Percent of programs
100
80
60
40
20
0
1.a 1.b 1.c 1.d 1.e 2.a 2.b 3.a 3.b
a b c d e
a b c
a b c d e f g h
a b c
Criterion 1
Criterion 2
Criterion 3
Criterion 4
Criterion 5
Montreal Process indicator
Percent of programs with comparable indicator(s) for each Montreal Process indicator in criteria 6–7
Percent of programs
100
80
60
40
20
0
1.a 1.b 1.c 1.d 1.e 1.f 2.a 2.b 2.c 3.a 3.b 3.c 3.d 4.a 4.b 5.a 5.b 5.c 5.d
1.a 1.b 1.c 1.d 1.e 2.a 2.b 2.c 2.d 2.e 3.a 3.b 4.a 4.b 4.c 5.a 5.b 5.c 5.d 5.e
Criterion 6
Criterion 7
Montreal Process indicator

*Refer to appendix A for the list of Montreal Process indicators.

Box 5. Montreal Process indicators that had the highest number of programs with comparable indicators

Criterion 1—Conservation of Biological Diversity

Extent of area by forest type relative to total forest area

Extent of area by forest type and by age class or successional stage

Fragmentation of forest types

The number of forest dependent species

The status (threatened, rare, vulnerable, endangered, or extinct) of forest dependent species at risk of not maintaining viable breeding populations, as determined by legislation or scientific assessment

Number of forest dependent species that occupy a small portion of their former range

Criterion 2—Maintenance of Productive Capacity of Forest Ecosystems

Annual removal of wood products compared to the volume determined to be sustainable

Criterion 3—Maintenance of Forest Ecosystem Health and Vitality

Area and percent of forest affected by processes or agents beyond the range of historic variation (e.g., by insects, disease, competition from exotic species, fire, storm, land clearance, permanent flooding, salinization, and domestic animals)

Criterion 4—Conservation and Maintenance of Soil and Water Resources

Area and percent of forest land managed primarily for protective functions (e.g., watersheds, flood protection, avalanche protection, riparian zones)

Percent of water bodies in forest areas (e.g., stream kilometers, lake hectares) with significant variation from the historic range of variability in pH, dissolved oxygen, levels of chemicals (electrical conductivity), sedimentation, or temperature change

Criterion 6—Maintenance and Enhancement of Long-term Multiple Socio-economic Benefits to Meet the Needs of Societies

Number and type of facilities available for general recreation and tourism, in relation to population and forest area

Criterion 7—Legal, Institutional, and Economic Framework for Forest Conservation and Sustainable Management

Provide for public involvement activities and public education, awareness and extension programs, and make available forest related information

Table 4. A large number of indicators did not fit well into the Montreal Process framework. The following categories of indicators that did not fit well are those that were used by five or more efforts.

Category	Representative examples	Number of efforts with such indicators
Land ownership	Ownership type and land use Percent of land owned by ownership types	7
Land use types (nonforestry)	Conversion of cropland to other uses Urban land use in Ohio	6
Wetlands	Acres of wetlands lost (or gained) Wetland type, functions, value trends; change in wetland function/value	6
Potential nutrient loading	Area treated with herbicides, pesticides, fertilizer, etc. Potential nitrogen loadings to streams	5

C. Further Information About This Analysis

Additional information about this analysis can be found in appendix G, including background research, database development, and a full list of efforts analyzed. In addition, summary information and lists of efforts (with links, where appropriate) are posted on the Northeastern Area's Sustainability Program Web site (http://www.na.fs.fed.us/sustainability/). Several types of database reports were also developed as a result of the analysis. A few of the reports developed and contained in the databases include a list of the efforts, a summary of the information displayed on a single page for each effort, definitions of key terms grouped by term, and reference information grouped by effort. These reports are available upon request.[4] Those who would like to explore and analyze the database content may request to receive an electronic copy of the databases (this is possible to the extent that the database software is compatible).

[4] To request a copy of the database(s), please contact Sherri Wormstead, NA Sustainability Program Assistant, at swormstead@fs.fed.us or 603-868-7737 or access additional information on-line at http://www.na.fs.fed.us/sustainability/.

V. Lessons Learned

In completing the evaluation of existing sustainability/indicators projects and drawing from the expertise of the NFRPA/NA C&I project work group, there are several lessons learned about the use of C&I, the process of C&I development and implementation, and the use of benchmarks in the C&I framework. Highlights of these lessons learned are presented here. The interested reader should also refer to section IV (Evaluation of Existing Sustainability/ Indicators Projects) and section VI (Recommended Criteria and Indicators Resources) of this sourcebook. Our understanding of the theory and practical uses of C&I will continue to evolve as progress is made in the many efforts that are still ongoing.

A. The Use of Criteria and Indicators

Why use criteria and indicators?

Useful for defining sustainability. Forest sustainability is an abstract concept that defies simple definition and explanation. However, criteria and indicators can help us measure important aspects of forest sustainability and articulate measurable goals, as well as describe the possible outcomes of various actions and decisions at many levels. Criteria and indicators of forest sustainability provide a logical framework by which people can monitor and assess trends in forest activities and values. Evaluating the full suite of a given set of C&I allows society to measure progress towards forest sustainability (Oregon Department of Forestry 2000a).

Convey critical and complex information simply. Assessments based on a well-constructed C&I framework can indicate the effectiveness of efforts to ensure high quality forest management and community development. To the degree C&I information contributes to sound policy and management decisions, it can build public confidence in forest management, decision making, and support for investments in forest sustainability.

Meet the demand for a holistic approach. A hierarchical structure of C&I is used to encompass a full range of sustainability-based values and/or goals. Indicators associated with each criterion describe components of ecological, social, and economic systems that can change. Because of the interconnections among ecological, social, and economic systems, there may be some overlap in the measurements used to address various indicators. The same data may have several interpretations depending upon the criteria and indicators they are used to address. For example, the amount of forest land of a given forest type has different implications for biological diversity, production of wood and nonwood products, water quality protection, recreation, and potential value-added in processing. Such overlap is natural and necessary to achieve a holistic assessment approach.

Can and should be used at a variety of scales. Values embedded in criteria transcend scale, thus they provide a vehicle for linking local, State, national, and global conditions, actions, and policy. Most countries (including the United States), several States, and numerous regional and local efforts support the use of criteria and indicators as a tool to promote discussions about sustainability. The National Research Council's *Ecological Indicators for the Nation* states, "Indicators can be useful at many levels—community, state, ecoregional,

watershed, national, and international—and better indicators are needed at all such scales" (National Research Council 2000, p. 2). It is important to match the scale of indicators to the scale of the ecological, social, and economic processes at which they are most useful.

What advantages are linked to the use of common indicators?

Promote linkages across multiple scales. This can be accomplished through the use of common indicators with different levels of resolution or generality. For example, indicators related to information on the amount and type of forest land are useful for all levels of planning and assessment, from local to international. At the international level, it may be sufficient to distinguish forest types in general categories such as coniferous and deciduous forests. At the regional level, forest type groups such as maple-beech-birch and oak-hickory are relevant. At the site level, the natural community with all floristic and structural components may be most relevant. It is also beneficial if indicators at different scales can be nested. As stated in a report from the Sustainability Institute (Meadows 1998, p. 22):

> At each of these levels, actions are taken and information is needed. We picture a nested set of indicators, each informing the "system in focus" at its own level (say, actual water quality in this lake) and aggregating to inform the system at the next higher level (average water quality in the region's lakes). Aggregation is necessary to keep from overwhelming the system at the higher levels of the hierarchy.

Facilitate communication and cooperation. Use of a common C&I framework could improve our ability to compare, develop, and share resource data and information across administrative and jurisdictional boundaries. A commitment to common criteria and indicators can help maximize the return on investments in resource inventory. It would provide a common vocabulary for Federal and State agencies and other stakeholders. In addition, a common framework could help identify opportunities for organizations with similar goals to work together. Many States are engaged in developing and implementating C&I, spearheaded by either State agencies or nonprofit groups. It is important for State forestry agencies to be aware of and participate in these existing C&I networks.

Help elucidate cumulative effects. The use of common indicators across jurisdictions provides an opportunity to capture cumulative effects. The influences of ecological, social, and economic systems and policies operating at different geographic and temporal scales can be illuminated by transcending political boundaries.

How are criteria and indicators used?

The development of C&I is not an end in and of itself; the real value is their utility in communicating important information about forests and forest management. While the development of C&I is an important and daunting task, C&I are a valuable tool when used in assessment, planning, issue management, inventory, monitoring, and communicating with others. They provide a format that supports scientifically based forest management and effective policy formulation.

Assessment. C&I serve as a logical framework for organizing successive assessment and reporting activities. A C&I assessment is an instrument to detect trends in ecological, social,

and economic systems. C&I assessments are proactive vehicles for routine early detection of critical trends. Assessments provide a synthesis of information in support of planning and decision making; however, they are not decision making documents.

Comprehensive strategic forest resource planning. The C&I framework is a planning tool to ensure that planning considers the full range of values and conditions important in setting goals and objectives for management and describing desired future conditions. C&I also serve as a monitoring tool to ensure that comprehensive and strategic forest resource plans are implemented. C&I should be used to identify where there are problems and identify potential management course corrections.

Issue management. Assessing or analyzing issues with C&I helps identify areas of common ground and opposing views among diverse stakeholders. In addition, it provokes thought about what needs to be done and who can do it. The C&I framework helps sort out what needs to be explicitly addressed. For example, as part of their strategic planning process, the Oregon Department of Forestry is using the criteria from the Montreal Process as a way to develop an organized list of issues that is exhaustive and mutually exclusive (Birch 2001). Developing a list of issues that fully articulates public concerns about a particular criterion, such as biological diversity or productive capacity, is much more manageable than trying to address sustainability as a whole.

Prioritize inventory and monitoring. C&I can be used to identify and prioritize information needs that will be addressed through inventory and monitoring programs. It is important to consider monitoring and reporting cycles since they may vary for individual indicators. C&I-based planning projects and assessments require inventory and monitoring data. Therefore, by extension, the framework will be useful in structuring a whole information system—a comprehensive inventory and monitoring program.

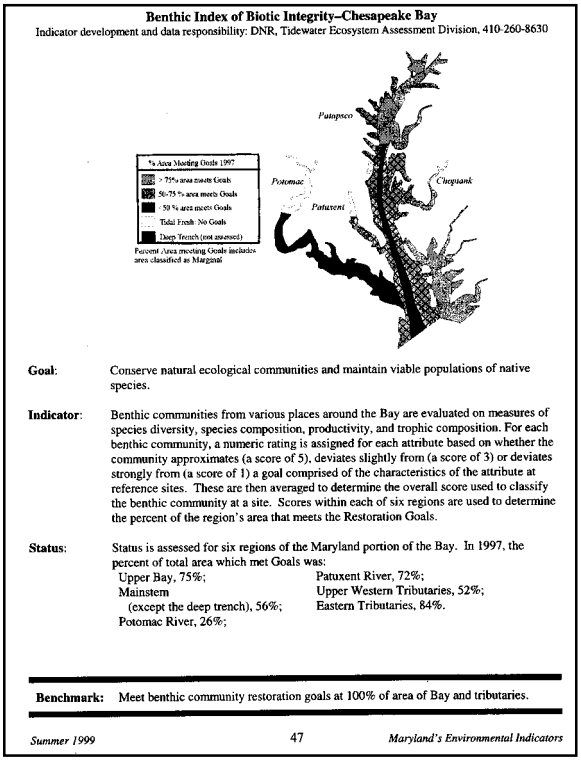
Communication. Concise, consistent, and easy to follow reports enable agencies, organizations, and the public to link sustainability goals and objectives to concrete measurements. Utilizing a Web-based reporting system allows the flexibility to update the data on an indicator-by-indicator basis as the data become available. However, periodic comprehensive reports are recommended. A handful of reports among the sustainability efforts evaluated were particularly good examples. In the reports from *Maryland's Environmental Indicators* and *New Jersey Future*, each indicator was presented in a consistent format with one indicator per page (figure 11).

The Maryland and New Jersey reports included some of the following components for each indicator:

- Indicator—indicator wording with definitions or clarification where necessary
- Importance—brief explanation of why the indicator is important
- Development and data responsibility—list of *who* is responsible for the indicator
- Goal—overarching goal or criterion the indicator is measuring
- Data—indicator data presented as a table, graph, or map
- Status—short trend statement (e.g., increasing) with brief explanation of data results

Figure 11. Example formats for reporting on indicators to decision makers and the public

Maryland's Environmental Indicators: A Status Report (Maryland Department of the Environment 1999)



Benthic Index of Biotic Integrity–Chesapeake Bay

Indicator development and data responsibility: DNR, Tidewater Ecosystem Assessment Division, 410-260-8630

Goal: Conserve natural ecological communities and maintain viable populations of native species.

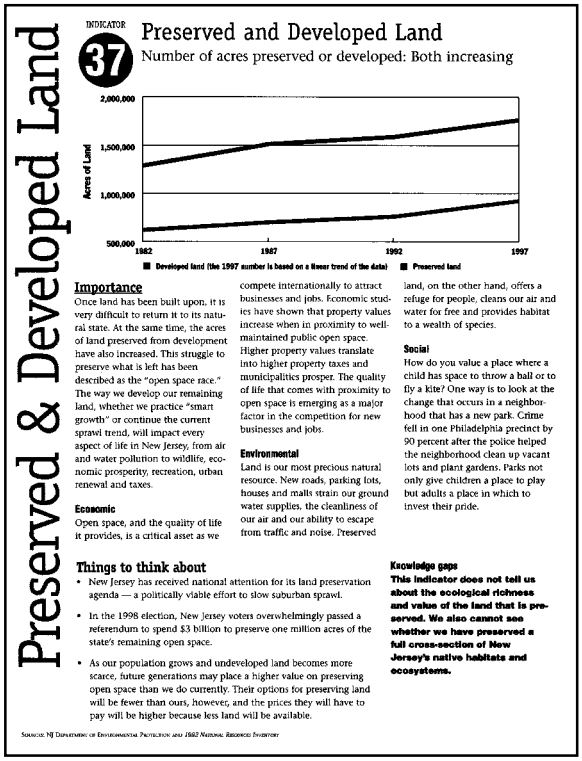
Indicator: Benthic communities from various places around the Bay are evaluated on measures of species diversity, species composition, productivity, and trophic composition. For each benthic community, a numeric rating is assigned for each attribute based on whether the community approximates (a score of 5), deviates slightly from (a score of 3) or deviates strongly from (a score of 1) a goal comprised of the characteristics of the attribute at reference sites. These are then averaged to determine the overall score used to classify the benthic community at a site. Scores within each of six regions are used to determine the percent of the region's area that meets the Restoration Goals.

Status: Status is assessed for six regions of the Maryland portion of the Bay. In 1997, the percent of total area which met Goals was:

Upper Bay, 75%;
Mainstem (except the deep trench), 56%;
Potomac River, 26%;
Patuxent River, 72%;
Upper Western Tributaries, 52%;
Eastern Tributaries, 84%.

Benchmark: Meet benthic community restoration goals at 100% of area of Bay and tributaries.

Living with the Future in Mind: Goals and Indicators for New Jersey's Quality of Life (New Jersey Future 1999)



Preserved & Developed Land

INDICATOR 37

Preserved and Developed Land

Number of acres preserved or developed: Both increasing

Importance

Once land has been built upon, it is very difficult to return it to its natural state. At the same time, the acres of land preserved from development have also increased. This struggle to preserve what is left has been described as the "open space race." The way we develop our remaining land, whether we practice "smart growth" or continue the current sprawl trend, will impact every aspect of life in New Jersey, from air and water pollution to wildlife, economic prosperity, recreation, urban renewal and taxes.

Economic

Open space, and the quality of life it provides, is a critical asset as we compete internationally to attract businesses and jobs. Economic studies have shown that property values increase when in proximity to well-maintained public open space. Higher property values translate into higher property taxes and municipalities prosper. The quality of life that comes with proximity to open space is emerging as a major factor in the competition for new businesses and jobs.

Environmental

Land is our most precious natural resource. New roads, parking lots, houses and malls strain our ground water supplies, the cleanliness of our air and our ability to escape from traffic and noise. Preserved land, on the other hand, offers a refuge for people, cleans our air and water for free and provides habitat to a wealth of species.

Social

How do you value a place where a child has space to throw a ball or to fly a kite? One way is to look at the change that occurs in a neighborhood that has a new park. Crime fell in one Philadelphia precinct by 90 percent after the police helped the neighborhood clean up vacant lots and plant gardens. Parks not only give children a place to play but adults a place in which to invest their pride.

Things to think about

- New Jersey has received national attention for its land preservation agenda — a politically viable effort to slow suburban sprawl.
- In the 1998 election, New Jersey voters overwhelmingly passed a referendum to spend $3 billion to preserve one million acres of the state's remaining open space.
- As our population grows and undeveloped land becomes more scarce, future generations may place a higher value on preserving open space than we do currently. Their options for preserving land will be fewer than ours, however, and the prices they will have to pay will be higher because less land will be available.

Knowledge gaps

This indicator does not tell us about the ecological richness and value of the land that is preserved. We also cannot see whether we have preserved a full cross-section of New Jersey's native habitats and ecosystems.

Sources: NJ Department of Environmental Protection and 1982 National Resources Inventory

- Benchmark—statement of the reference condition or the desired condition
- Knowledge gaps—description of important knowledge gaps and relevant steps to address these gaps
- Things to think about—short statements intended to make connections between the indicator results and other aspects of sustainability and present further facts that support the illustrated indicator trend

These indicator reports are exemplary in that complex scientific information was clearly and consistently presented in a space-limited format. In addition to the indicator report pages shown here, both of these reports included preceding pages that presented and described each criterion or goal. Both reports had effective formats for reporting on C&I to decision makers and the public. Reporting on the indicators is a critical component of the often iterative process of indicator development and implementation. As stated in a report published by the Sustainability Institute, publishing and promoting the indicators "requires translating them into striking graphics, clear language, and an effective outreach campaign. It helps to link the indicators to the policies and driving forces that affect them, to illustrate their linkages, and to point to the actions that can be taken to improve them" (Meadows 1998, p. 27).

How can a criteria and indicators assessment be conducted?

There are a number of activities common to C&I-based assessment processes.

- Determine the degree of public involvement you desire.
- Identify your data needs and availability, deciding how to handle gaps in desired information.
- Develop clear data definitions and methods of measurement.
- Agree on the target audience(s) and degree of interpretation to be provided in the assessment report.
- Establish clear linkages between the objectives of your assessment and those of other efforts (certification, planning, department projects).
- Look for opportunities to leverage resources for mutual benefit.

Work with public and professional stakeholders. Identify and work with stakeholders to ensure credibility and usefulness. At a minimum, identify others whose help will be needed to carry out the endeavor. Include decision makers likely to benefit from the information provided and stakeholders active in the assessment area. At the local scale, residents should be included. Opportunities for professional involvement include the development of criteria and indicators, providing quality assurance, data management, and indicator interpretation. Assessments can be a powerful vehicle for promoting public involvement in resource planning and decision making. Involvement early in the assessment process creates understanding about criteria and indicators and supporting data that will carry into planning and decision making processes.

Clearly state the assumptions used to interpret data. Indicators normally are constructed to describe conditions or, more specifically, the pace of change in some given condition. Indicators may provide insight into cause and effect relationships when they are interpreted with reference to a specific spatial, temporal, or conceptual context that is relevant to the criterion under discussion. Examples of a spatial context include ecosystem, watershed, State, and community. The historical range of variability is a temporal context. A conceptual context is intergenerational equity—the degree to which benefits are distributed among present and future generations.

Recognize that C&I can't do all things. There are many information needs that must be met through venues other than C&I monitoring and assessment. Criteria and indicators are a useful tool for the purposes described above; however, there is a continuing need for other types of information to solve natural resource management problems and to manage resources effectively.

B. The Process of Criteria and Indicators Development and Implementation

Implementation of C&I is an iterative process. This process includes development of indicators, identification and standardization of data to support each indicator, reporting on indicators, and indicator revision. The measures used, and even the indicators themselves, are subject to revision in accordance with underlying science, data availability, and

experience. Development of an initial set of indicators may take 1 to 3 years alone, depending upon stakeholder involvement and the nature of the planning process with which it is affiliated. Therefore, to be done well, C&I implementation requires a long-range commitment as well as flexibility to adapt C&I content and processes as more experience is gained.

What makes a good indicator?

It is critical to carefully evaluate potential indicators. Several groups and reports have examined the question of what constitutes a "good" indicator (Williams and others 1998). Those reports have consistently identified the following characteristics:

- ***Relevance to criterion***—Indicators should be clearly related and relevant to the criterion.
- ***Understandable***—Indicators should be clear in content: easily understandable, with units that make sense, expressed in imaginable, not eye-glazing, numbers. The indicator should pass the common sense test applied by the general public.
- ***Measurable***—Indicators should be measurable on a consistent, reliable basis, using well-defined data that can be compiled without long delays.
- ***Policy relevant***—Indicators should be relevant for all stakeholders in the system, including the least powerful.
- ***Feasible***—The value of the information provided by an indicator should not exceed the cost to gather it.
- ***Sufficient to the purpose***—Indicators should not contain too much information to comprehend, nor too little information to give an adequate picture of the situation.
- ***Sensitive to change***—Changes in the forest, whether from human actions or natural changes, should elicit a response in an indicator in time to act on it.
- ***Scale appropriate***—Indicators should be measurable at a scale appropriate to that of the forest sustainability monitoring effort and not over- or under-aggregated.
- ***Compatible***—With the exception of locally important indicators, indicators should "roll up" into State, regional, and national efforts to define criteria and indicators of forest sustainability.

Quantitative or qualitative. Indicators may be measured in a quantitative or qualitative way. If quantitative data are not available, qualitative information can be used to demonstrate changed conditions. It is just as important to provide clear definitions for qualitative information as it is for quantitative information.

One or more metrics may be needed. Data types and measurement protocols used in inventory and monitoring are called metrics or verifiers. An individual indicator may be measured with one metric (acres), several metrics (size and growth rate), or a calculation based on several metrics (carbon flux).

Scale is an important consideration. Scale affects the cost of implementation, statistical design, data availability, and data compatibility across jurisdictions. The precision and

accuracy of inventories is tied to scale. Common measures are crucial for comparing conditions among jurisdictions at a given scale. Standardization simplifies the aggregation of data from local to global scales.

How are indicators developed?

Common steps in indicator development include the following (adapted from Meadows 1998):

- ***Select a small working group.*** The working group, responsible for the success of the venture, should be multidisciplinary, with strong ties to the audience for which the indicators are intended. The working group is most effective when it combines experts and non-experts from the outset, but the critical element is long-term commitment to the process.
- ***Clarify the purpose of the indicator set.*** It is important to determine whether the indicator set is meant to educate the public, provide background for key policy decisions, evaluate the success of an initiative or plan, or address multiple purposes. Different purposes give rise to different indicators and different communication strategies.
- ***Review existing models, indicators, and data.*** Begin the process of indicator development by doing some homework on previous work. The Montreal Process indicators are recommended as a starting point with advantages as stated previously. Research what existing or prior work has been done in your region and State. Understand what a criteria and indicators framework can and cannot do for you. Evaluate your needs with close attention to the level of detail needed to support assessment and decision making.
- ***Draft a set of proposed indicators.*** The working group draws on its own knowledge, the examples it has collected, and the advice of outside experts, if needed, to prepare a first draft. The draft may go through several revisions before it is ready for the next step. Initial indicator sets, in particular, tend to be very long. In later drafts, they need to be pruned down to become more focused and practical.
- ***Provide an opportunity for review of indicators.*** The draft indicators need to be presented to a broad cross-section of the community for their input. This process serves several important goals: it educates the participants, gathers their collective creativity and expertise, and makes them stakeholders in the success of the project. Often, it gives rise to new relationships and alliances among the participants and can even generate new action initiatives to address problems identified by the indicators.
- ***Perform a technical review.*** An interdisciplinary team of knowledgeable people should sort through the proposed final draft indicators, considering such things as measurability, statistical and systemic relevance, and scale, trying to stay true to the intentions and preferences expressed by the wider stakeholder review process. This technical review helps to fill in gaps and weed out technical problems, and produces a final indicator set that is ready to be fleshed out with data.
- ***Research the data.*** Identify data needs and availability, and develop a common understanding of data definitions and the pros and cons of specific metrics. At this stage,

the indicators are usually subject to additional revision, driven by data concerns and new learning. If you are responsible for inventory and monitoring design, develop standard protocols and quality control and assurance mechanisms.

Indicators should tap into our understanding of how ecological, social, and economic systems operate and interact. In order to separate what *should* be measured as indicators from what *could* be measured, it is helpful to clearly articulate the important components of ecological, social, and economic systems pertinent to the suite of criteria you have adopted in your effort. Ecological, social, and economic system frameworks developed through the USDA Forest Service's LUCID project are available for this purpose (USDA Forest Service 2001b). The frameworks help in selecting indicators by providing a mechanism to evaluate the spatial, temporal, and values-based context of potential indicators.

A coherent information system is needed. To provide information about forest sustainability, a whole information system is needed from which indicators can be derived. Therefore, while developing indicators, it is important to think about the development of an information system of which indicators are just one part. For example, when discussing indicator development, the Balaton Group, an international network of sustainable development scholars and activists, realized that they were also referring to "the design of not only the instrument panel (indicators) that governments and citizens need to see to steer the ship and avoid obstacles, but also the design of the background wiring (information system) that collects and sorts information and delivers it to the panel" (Meadows 1998, p. 28).

Do indicators need to be measurable at this point in time?

Do not eliminate indicators that are not currently measured. It is tempting when narrowing a list of potential indicators to think, "If you cannot measure it, it is not worth considering." However, do not preclude important indicators that are not currently measured. It is often possible to identify surrogate measures, such as in the fashion of the *Maine Forest Sustainability Standards*' use of proxy indicators (Maine Forest Service 1999). Research and representative case studies can also be used to document significant trends if inventories are based on incomplete or incompatible information.

Who are the audiences for C&I reports?

Consider the target audience(s) and their use of the C&I information. It is helpful to have a clear sense of the target audience(s) and their use of C&I information when developing an indicator set and determining what outreach strategy to use. The most common target audiences are the general public, decision makers, and both public and private forest managers. C&I can be used as a vehicle to raise awareness among the general public, to raise issues and provide information on program and policy effects important to decision makers, and to serve as a critical source of information on forest conditions, trends, and responses for forest managers committed to adaptive management.

Audiences can be targeted in several ways; the following are two approaches.

- ***Tiered Approach.*** Identify overlapping levels of indicators with each level targeted to a specific audience/purpose (tiers of indicators similar to those in Oregon Department of

Forestry 2000b). Among the benefits of this tiered approach is the ability to break a larger, more comprehensive list of indicators into smaller, more easily accomplished pieces, while simultaneously producing tangible products that meet critical information needs for target audiences. A consequence of this approach is that there may be variations in data currency across reports generated, leading to some miscommunication among the various targeted groups.

- ***Targeted Communication.*** Identify one comprehensive suite of indicators (e.g., the 67 identified in the Montreal Process) and use a communications strategy to excerpt the information appropriate for each target audience/purpose. In essence, measure once, but report out in multiple ways. This approach is being used in the *Forest Sustainability Assessment Report for the Northern United States* (USDA Forest Service 2001a). A benefit of this approach is that multiple targeted user groups will reference the same data. A consequence is that difficulties in data compilation and interpretation for a small portion of the indicators can delay public dissemination of the larger volume of information.

How many indicators are needed to address sustainability?

There is no magic number of indicators to meet the needs of all potential users of criteria and indicators information. Different indicator sets are used to meet the needs of all potential users of C&I information. The number of indicators necessary will vary with the scale, intended use, and outreach strategy chosen.

A comprehensive set addresses the major aspects of each criterion. At minimum, a sustainability criteria and indicators set should address important conditions and processes of ecological, social, and economic systems and strive to achieve balance among the three. A comprehensive set of indicators should address the major aspects of each and all agreed upon criterion.

A balancing act between concise and sufficient. It is difficult to balance the need for a concise list of indicators with the need for a list that is sufficient to address sustainability. Generally, the higher the number of indicators, the greater the time and expense incurred collecting and assessing information. These pragmatic issues cannot be ignored. Costs can be controlled by reducing the resolution of data used for assessment and increasing reporting cycle length. A C&I framework also helps streamline organizational inventory, monitoring, and data management efforts by reducing redundancy and utilizing state-of-the-art data capture methods. It may be helpful to phase in the use of a comprehensive set of indicators following an agreed upon timetable.

C. The Use of Benchmarks in the Criteria and Indicators Framework

What are sustainability benchmarks?

A point of reference or reference condition. "With respect to indicators, the most common definition of a benchmark is: a point of reference, or reference condition, from which measurements can be made or a standard against which others may be judged" (Bridge and others 2002, p. 3). Their purpose is to gauge the effectiveness of planned actions by gauging the outcome of those actions against a desirable or undesirable outcome. Benchmarks can be statements of desired condition (e.g., specific acreage in protected areas), a defined reference

point (historical condition, desired future condition, threshold condition), or a policy or program performance target. Benchmarks may be quantitative or qualitative.

Why use sustainability benchmarks?

Set clear public expectations. Benchmarks set clear public expectations for measurable outcomes from management activities, programs, and policies. When linked to indicators of sustainability, benchmarks help promote outcome-based forest policy with the goal of providing a more stable and predictable public policy that supports and encourages long-term investment in forests. For example, the Maine Forest Service (1999, p. 27) believes that "the State should begin to focus more on outcome-based forestry regulation, on the premise that this approach will do more to promote, stimulate, and reward excellent forest management yet still provide a baseline of regulatory protection for critical public resources."

Can be linked to the C&I framework through reference to specific indicators. A benchmark can be linked to a specific indicator by basing the benchmark on the metric(s) or data used to monitor trends for a given indicator. Benchmarks can provide a context for interpreting an indicator. For example, it may be possible to define statements about the desired future direction of change in the indicator (Bridge and others 2002).

How are sustainability benchmarks developed?

Should be set in an open public process. A transparent process brings credibility to the use of benchmarks. Sound science is a prerequisite to the benchmark setting process. However, benchmarks, especially for indicators that deal with ecological, social, and economic tradeoffs and investments in forests or forest management, are heavily dependent on public values. Achieving agreement in these situations may require lengthy or complex negotiations.

A lack of knowledge or information can make it difficult to set meaningful benchmarks. For example, lack of information on the amount of nonwood forest product harvesting and the effects of this harvesting on ecosystem resilience makes it difficult to set a benchmark based on either harvest volumes, standing inventory, or ecosystem condition. As noted by Bridge and others (2002), "In some instances, the science supporting the indicator is so new that establishing credible benchmarks is difficult or unwarranted until further research is completed" (p. 2). Benchmarks will have varying levels of precision due to lack of data, tools, scientific understanding, or simply the nature of the indicator.

VI. Recommended Criteria and Indicators Resources

Web Sites

Montreal Process Working Group—http://www.mpci.org/home_e.html

Northeastern Area Sustainability Program—http://www.na.fs.fed.us/sustainability

Sustainable Measures—http://www.sustainablemeasures.com

U.S. Roundtable on Sustainable Forests—http://www.sustainableforests.net

Printed Resources

Ecological Indicators for the Nation.
Committee to Evaluate Indicators for Monitoring Aquatic and Terrestrial Environments, Board on Environmental Studies and Toxicology [and] Water Science and Technology Board, Commission on Geosciences, Environment, and Resources, National Research Council. 2000. Washington, DC: National Academy Press. 180 p. [ISBN 0-309-06845-2].

Guide to Sustainable Community Indicators, Second Edition.
Hart, Maureen. 1999. North Andover, MA: Hart Environmental Data [Sustainable Measures]. 202 p.

Hierarchical Framework for the Formulation of Sustainable Forest Management Standards.
Lammerts van Bueren, Erik M.; Blom, Esther M. 1997. The Netherlands: The Tropenbos Foundation. 82 p. [ISBN 90-5113-031-7]

Indicators and Information Systems for Sustainable Development: A Report to the Balaton Group.
Meadows, Donella. 1998. Harland Four Corners, VT: The Sustainability Institute. 78 p. [http://www.sustainabilityinstitute.org]

Web Sites for Other Sustainability/Indicators Efforts

Canadian Council of Forest Ministers—http://www.ccfm.org

Chesapeake Bay Program—http://www.chesapeakebay.net/indicators.htm

Great Lakes Forest Alliance Sustainable Forest Management C&I Project—http://www.lsfa.org

Local Unit Criteria and Indicators Development Project—http://www.fs.fed.us/institute/lucid

Maryland Environmental Indicators—http://www.mde.state.md.us/enpa/2000_enpa/envi_indicators

Maine Sustainability Standards—http://www.state.me.us/doc/mfs/mfshome.htm (publications)

Minnesota Environmental Indicators Initiative—http:///www.dnr.state.mn.us/eii/

Minnesota's Sustainable Forests Program—http://www.frc.state.mn.us/SFRA/SFRA.htm

New Jersey Future—http://www.njfuture.org/

Northern Forest Wealth Index—http://www.northernforest.org/techwindex.htm

Oregon Forest Assessment Projects—http://www.odf.state.or.us/rp/FAR/FARdefault.html

Report on the State of the Nation's Ecosystems—http://www.us-ecosystems.org

Selection of Indicators for the Great Lakes—http://www.epa.gov/glnpo/solec/

Vermont Forest Resources Plan and Indicators—http://www.state.vt.us/anr/fpr/forestry/forplan

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APPENDIX A. THE MONTREAL PROCESS CRITERIA AND INDICATORS

In 1992 the United Nations sponsored a Conference on Environment and Development (UNCED), commonly referred to as the "Earth Summit," in Rio de Janeiro, Brazil. At the Earth Summit, over 144 nations recognized the importance of sustainably managing all types of forests in order to meet the needs of present and future generations by adopting a nonbinding Statement of Forest Principles (Sitarz 1994).

The Montreal Process developed as a result of efforts following the Earth Summit. The United Nations Conference on Security and Cooperation in Europe sponsored an international seminar in Montreal, Canada, on sustainable development of temperate and boreal forests. This conference provided a forum for discussions on how to measure and track progress toward the goal of sustainability. These discussions provided the conceptual basis for subsequent regional and international initiatives to develop (1) criteria, which provide a large-scale reflection of public values, and (2) indicators, which provide a means of measuring forest conditions and tracking changes in ecological, social, and economic conditions.

In 1995, the United States endorsed a statement of political commitment to use criteria and indicators to track progress in sustainability. The signatory document, known as the "Santiago Declaration," includes a comprehensive set of 7 criteria (3 of which have subcriteria) and 67 indicators for the conservation and sustainable management of temperate and boreal forests. The signatories to this nonbinding declaration are Argentina, Australia, Canada, Chile, China, Japan, the Republic of Korea, Mexico, New Zealand, the Russian Federation, the United States, and Uruguay. These 12 countries contain 90 percent of the world's temperate and boreal forests, which account for 60 percent of all forests on the globe (Montreal Process Working Group 2001). They account for 45 percent of related world trade and 35 percent of the world's population.

The United States issued *The First Approximation Report for Sustainable Forest Management: Report of the United States on the Criteria and Indicators for the Sustainable Management of Temperate and Boreal Forests* on June 6, 1997 (USDA Forest Service 1997). This report laid the foundation for an ongoing process to assess forest management and monitoring capability across the country. A consolidated report from all Montreal Process Working Group countries was presented to the Eleventh World Forestry Congress in Antalya, Turkey, in October 1997. The European countries decided it was important to work as a region under an existing Helsinki Ministerial Declaration. Their criteria and indicators effort is called the Helsinki Process or the Pan-European Process.

The following forest sustainability criteria and indicators were developed as a result of the Montreal Process and are called the Montreal Process Criteria and Indicators for the Conservation and Sustainable Management of Temperate and Boreal Forests.

The Montreal Process Criteria and Indicators for the Conservation and Sustainable Management of Temperate and Boreal Forests*

Criterion 1—Conservation of Biological Diversity

1.1 Ecosystem Diversity

1.1.a. Extent of area by forest type relative to total forest area

1.1.b. Extent of area by forest type and by age class or successional stage

1.1.c. Extent of area by forest type in protected area categories as defined by IUCN or other classification systems

1.1.d. Extent of areas by forest type in protected areas defined by age class or successional stage

1.1.e. Fragmentation of forest types

1.2 Species Diversity

1.2.a. The number of forest dependent species

1.2.b. The status (threatened, rare, vulnerable, endangered, or extinct) of forest dependent species at risk of not maintaining viable breeding populations, as determined by legislation or scientific assessment

1.3 Genetic Diversity

1.3.a. Number of forest dependent species that occupy a small portion of their former range

1.3.b. Population levels of representative species from diverse habitats monitored across their range

Criterion 2—Maintenance of Productive Capacity of Forest Ecosystems

2.a. Area of forest land and net area of forest land available for timber production

2.b. Total growing stock of both merchantable and nonmerchantable tree species on forest land available for timber production

2.c. The area and growing stock of plantations of native and exotic species

2.d. Annual removal of wood products compared to the volume determined to be sustainable

2.e. Annual removal of nontimber forest products (e.g., fur bearers, berries, mushrooms, game), compared to the level determined to be sustainable

Criterion 3—Maintenance of Forest Ecosystem Health and Vitality

3.a. Area and percent of forest affected by processes or agents beyond the range of historic variation (e.g., by insects, disease, competition from exotic species, fire, storm, land clearance, permanent flooding, salinization, and domestic animals)

3.b. Area and percent of forest land subjected to levels of specific air pollutants (e.g., sulfates, nitrate, ozone) or ultraviolet that may cause negative impacts on the forest ecosystem

3.c. Area and percent of forest land with diminished biological components indicative of changes in fundamental ecological processes (e.g., soil nutrient cycling, seed dispersion, pollination) and/or

* No priority or order is implied in the numeric listing of the criteria and indicators.

ecological continuity (monitoring of functionally important species such as fungi, arboreal epiphytes, nematodes, wasps, etc.)

Criterion 4—Conservation and Maintenance of Soil and Water Resources

4.a. Area and percent of forest land with significant soil erosion

4.b. Area and percent of forest land managed primarily for protective functions (e.g. watersheds, flood protection, avalanche protection, riparian zones)

4.c. Percent of stream kilometers in forested catchments in which stream flow and timing has significantly deviated from the historic range of variation

4.d. Area and percent of forest land with significantly diminished soil organic matter and/or changes in other soil chemical properties

4.e. Area and percent of forest land with significant compaction or change in soil physical properties resulting from human activities

4.f. Percent of water bodies in forest areas (e.g., stream kilometers, lake hectares) with significant variance of biological diversity from the historic range of variability

4.g. Percent of water bodies in forest areas (e.g., stream kilometers, lake hectares) with significant variation from the historic range of variability in pH, dissolved oxygen, levels of chemicals (electrical conductivity), sedimentation, or temperature change

4.h. Area and percent of forest land experiencing an accumulation of persistent toxic substances

Criterion 5—Maintenance of Forest Contribution to Global Carbon Cycles

5.a. Total forest ecosystem biomass and carbon pool, and if appropriate, by forest type, age class, and successional stages

5.b. Contribution of forest ecosystems to the total global carbon budget, including absorption and release of carbon (standing biomass, coarse woody debris, peat and soil carbon)

5.c. Contribution of forest products to the global carbon budget

Criterion 6—Maintenance and Enhancement of Long–term Multiple Socio-economic Benefits to Meet the Needs of Societies

6.1 Production and Consumption

6.1.a. Value and volume of wood and wood products production, including value added through downstream processing

6.1.b. Value and quantities of production of nonwood forest products

6.1.c. Supply and consumption of wood and wood products, including consumption per capita

6.1.d. Value of wood and nonwood products production as a percentage of GDP

6.1.e. Degree of recycling of forest products

6.1.f. Supply and consumption/use of nonwood products

6.2 Recreation and Tourism

6.2.a. Area and percent of forest land managed for general recreation and tourism, in relation to the total area of forest land

6.2.b. Number and type of facilities available for general recreation and tourism, in relation to population and forest area

6.2.c. Number of visitor days attributed to recreation and tourism, in relation to population and forest area

6.3 Investment in the Forest Sector

6.3.a. Value of investment, including in forest growing, forest health and management, planted forests, wood processing, recreation, and tourism

6.3.b. Level of expenditure on research and development, and education

6.3.c. Extension and use of new and improved technologies

6.3.d. Rates of return on investment

6.4 Cultural, Social, and Spiritual Needs and Values

6.4.a. Area and percent of forest land managed in relation to the total area of forest land to protect the range of cultural, social, and spiritual needs and values

6.4.b. Nonconsumptive use forest values

6.5 Employment and Community Needs

6.5.a. Direct and indirect employment in the forest sector and forest sector employment as a proportion of total employment

6.5.b. Average wage rates and injury rates in major employment categories within the forest sector

6.5.c. Viability and adaptability to changing economic conditions of forest dependent communities, including indigenous communities

6.5.d. Area and percent of forest land used for subsistence purposes

Criterion 7—Legal, Institutional, and Economic Framework for Forest Conservation and Sustainable Management

7.1 Extent to which the *legal framework* (laws, regulations, guidelines) supports the conservation and sustainable management of forests, including the extent to which it:

7.1.a. Clarifies property rights, provides for appropriate land tenure arrangements, recognizes customary and traditional rights of indigenous people, and provides means of resolving property disputes by due process

7.1.b. Provides for periodic forest-related planning, assessment, and policy review that recognizes the range of forest values, including coordination with relevant sectors

7.1.c. Provides opportunities for public participation in public policy and decision making related to forests and public access to information

7.1.d. Encourages best practice codes for forest management

7.1.e. Provides for the management of forests to conserve special environmental, cultural, social, and/or scientific values

7.2 Extent to which the *institutional framework* supports the conservation and sustainable management of forests, including the capacity to:

7.2.a. Provide for public involvement activities and public education, awareness and extension programs, and make available forest-related information

7.2.b. Undertake and implement periodic forest-related planning, assessment, and policy review including cross-sectoral planning and coordination

7.2.c. Develop and maintain human resource skills across relevant disciplines

7.2.d. Develop and maintain efficient physical infrastructure to facilitate the supply of forest products and services and support forest management

7.2.e. Enforce laws, regulations, and guidelines

7.3 Extent to which the *economic framework* (economic policies and measures) supports the conservation and sustainable management of forests through:

7.3.a. Investment and taxation policies and a regulatory environment which recognize the long-term nature of investments and permit the flow of capital in and out of the forest sector in response to market signals, nonmarket economic valuations, and public policy decisions in order to meet long-term demands for forest products and services

7.3.b. Nondiscriminatory trade policies for forest products

7.4 Capacity to *measure and monitor* changes in the conservation and sustainable management of forests, including:

7.4.a. Availability and extent of up-to-date data, statistics, and other information important to measuring or describing indicators associated with criteria 1–7

7.4.b. Scope, frequency, and statistical reliability of forest inventories, assessments, monitoring, and other relevant information

7.4.c. Compatibility with other countries in measuring, monitoring, and reporting on indicators

7.5 Capacity to conduct and apply *research and development* aimed at improving forest management and delivery of forest goods and services, including:

7.5.a. Development of scientific understanding of forest ecosystem characteristics and functions

7.5.b. Development of methodologies to measure and integrate environmental and social costs and benefits into markets and public policies, and to reflect forest-related resource depletion or replenishment in national accounting systems

7.5.c. New technologies and the capacity to assess the socio-economic consequences associated with the introduction of new technologies

7.5.d. Enhancement of ability to predict impacts of human intervention on forests

7.5.e. Ability to predict impacts on forests of possible climate change

Source: Montreal Process Working Group 1999

APPENDIX B. NORTHEASTERN FOREST RESOURCE PLANNERS ASSOCIATION/ NORTHEASTERN AREA CRITERIA AND INDICATORS PROJECT WORK GROUP

Connie Carpenter **Margaret Miller-Weeks** **Sherri Wormstead**	USDA Forest Service Northeastern Area State and Private Forestry Durham, New Hampshire
Donald Mansius	Maine Department of Conservation Maine Forest Service Augusta, Maine
Larry Pedersen	Michigan Department of Natural Resources Forest, Mineral, and Fire Management Division Lansing, Michigan
Jon Nelson **Clarence Turner**	Minnesota Department of Natural Resources Division of Forestry St. Paul, Minnesota
Susan Francher	New Hampshire Department of Resources and Economic Development Division of Forests and Lands Concord, New Hampshire
Dan Devlin, Work Group Chair **Jim Ruff**	Pennsylvania Department of Conservation and Natural Resources Bureau of Forestry Harrisburg, Pennsylvania

NAASF Liasions:

Gerald Thiede July 2000–July 2001	Michigan Department of Natural Resources Forest, Mineral, and Fire Management Division Lansing, Michigan
Austin Short July 2001–Present	Delaware Department of Agriculture Forestry Section Dover, Delaware

APPENDIX C. NORTHEASTERN AREA ASSOCIATION OF STATE FORESTERS CRITERIA AND INDICATORS PROJECT MOTIONS

JULY 2000 NAASF MOTION

NA Forest Sustainability C&I Effort

NA and NFRPA to:

1. Continue the clearinghouse function regarding sustainability efforts
2. Develop a guidebook to assist the States concerning criteria and indicators
3. Recommend 10 and no more than 15 key indicators consistent with the Montreal Process criteria
4. Identify the current status of the data needed for key indicators and impediments to collection of that data
5. Update NAASF on progress at the winter 2000 meeting
6. Full report including the guidebook and indicators to NAASF at the summer 2001 meeting

JULY 2001 NAASF MOTION

Concerning the Development of C&I of Forest Sustainability

NAASF applauds the efforts to date by the NFRPA/NA C&I project work group, recognizing the contribution of NA as well as individual States.

That the NFRPA/NA C&I project work group should:

- Survey individual NA States to determine which data from the base set of indicators, not already identified as available, are collected on a State level.
- For any indicator for which data are consistently collected among all 20 States, that indicator shall be moved to the available list.
- The group will identify any inconsistencies and gaps in the collection of data between States and develop recommendations for addressing these inconsistencies and gaps, including the use of Forest Inventory and Analysis Program data.
- A report of this work and any updates to the sourcebook will be forwarded to State Foresters 30 days before the NAASF winter 2001 meeting.
- A report that includes compilation of available data and identification of data inconsistencies and gaps will be provided at the summer 2002 meeting.

NAASF will target completion and adoption of the sourcebook and adoption of the list of base indicators for the winter 2001 meeting.

NAASF believes that collection of accurate data and tracking trends in the data are more important than establishing benchmarks, at least for the immediate future.

Every 5 years, at a minimum, an NA-wide C&I assessment report will be developed.

NAASF will identify an official liaison/committee to work with the NFRPA/NA C&I project work group on a continuing basis.

NOVEMBER 2001

The NFRPA/NA C&I project work group made the following recommendations to NAASF:

1. NAASF to approve the *Sourcebook on Criteria and Indicators of Forest Sustainability in the Northeastern Area.*
2. NAASF to approve and adopt the NA base set of indicators.
3. By the NAASF summer 2002 meeting, NFRPA/NA C&I project work group to:
    - Identify data inconsistencies and gaps, and make recommendations for addressing them
    - Recommend metrics for implementation of the base indicators across the 20 States
4. The following year, NFRPA/NA C&I project work group to:
    - Continue to address issues of data inconsistencies and gaps
    - Assemble available data and begin posting on the NA Sustainability Web site
    - Report on progress at NAASF winter 2002 meeting
5. Every 5 years, at a minimum, an NA-wide C&I assessment report will be developed.
6. NAASF to allow for refinement of the base indicators and associated data as policy, science, and technology evolves.

NAASF approved the recommendations with the following caveats:

- Need to establish a State Forester data review process for all data published or posted on Web sites (NFRPA/NA C&I project work group to recommend a data review process at the NAASF summer 2002 meeting).
- Anywhere the base indicators are presented, a qualifier statement should be included that promotes the indicators as a whole set and notes that they are not ranked/prioritized.
- Approval of these recommendations should not obligate staff on the part of the States. If data from any States are missing, it must be reported that the data are an aggregation of a certain number of States.
- It is important to tie the release of data (reports) to the NA strategic plan.
- Any refinement of the base indicators should be reviewed by NAASF.
- Develop a "popularized" publication to highlight the importance of C&I and present this effort to the general public (to be a joint NAASF-NA document with recognition of the work by NFRPA).

APPENDIX D. DEVELOPMENT OF INDICATORS FOR THE NORTHEASTERN AREA

The process followed to develop the recommended set of base forest sustainability indicators for the Northeastern Area is similar to the processes taken by many other C&I efforts. As requested by NAASF, the NFRPA/NA C&I project work group developed and implemented an indicator selection process. During a half-day meeting in October 2000, the work group agreed on the process for indicator development. This process entailed six major steps: (1) agree on the indicator evaluation method, (2) develop an initial set of potential NA indicators, (3) evaluate potential NA indicators, (4) narrow the indicator list and adjust the wording of the potential NA indicators, (5) send out the draft set of indicators for peer review and evaluation, and (6) consider the results of indicator review and evaluation (box 6). This process of indicator selection for the Northeastern Area demanded a majority of the work group's time.

To complete step 1 of the process, the work group identified and agreed on the indicator evaluation method. This included agreeing on a list of important questions that potential

Box 6. Process for developing indicators of forest sustainability for use in the Northeastern Area

1. Agree on an indicator evaluation method.

- Develop indicator evaluation questions and worksheets.

2. Develop an initial set of potential NA indicators (not limited to 10–15).

Each C&I working group member drafts a list of potential indicators.
Consider the following:
- Analyze the Montreal Process indicators for potential applicable indicators.
- Look at indicators from other programs, e.g., *Maine Forest Sustainability Standards, Great Lakes Forest Alliance, Local Unit Criteria & Indicators Development Project (LUCID), Sustaining Penn's Woods, Minnesota Environmental Indicators Initiative, Sustainable Forestry Initiative Program*.
- Consider whether there are additional long-term issues of critical concern to forest sustainability in the Northeastern Area for which indicators should be developed.

3. Evaluate potential NA indicators.

- Each member of the work group evaluates each indicator (results compiled and redistributed to group).

4. Narrow the indicator list and adjust the wording of the potential NA indicators.

From the results of the indicator evaluation:
- Agree on a narrowed set of indicators (narrow to a set of no more than 20–25 indicators).
- Agree on the wording of each indicator (making corrections and adjustments where necessary).

5. Send out this draft set of indicators for peer review and evaluation.

6. Consider the results of indicator review and evaluation:

- Narrow the list of indicators to the set that will be presented to NAASF.
- Refine the wording of indicators and indicator definitions, where necessary.

Present the recommended set of indicators to NAASF at the summer 2001 meeting.

indicators should be evaluated by. Several key resources were consulted to formulate an appropriate list of indicator evaluation questions, which include consideration of the indicator wording, C&I framework, data/measurement issues, and indicator use concerns (box 7). The indicator evaluation questions were agreed upon at the October 2000 meeting of the work group.

Steps 2 through 4 of indicator development were carried out as an iterative process to evaluate and prioritize potential indicators. This process began with each work group member individually proposing a set of potential forest sustainability indicators for the

Box 7. Indicator evaluation questions used to evaluate potential indicators

Indicator Wording Checklist

- ❑ The indicator is precisely defined.
- ❑ The indicator is a specific and measurable parameter (not too vague).
- ❑ The indicator is written nondirectionally (not suggesting a response in either direction).
- ❑ The indicator wording does not include or imply the methods or reference values (target/threshold).

C&I Framework Questions

1. Is the indicator closely and unambiguously related to one of the Montreal Process criteria?
2. Does the indicator link to or feed into any of the Montreal Process indicators? (Contribution of region to national reporting) Which ones?
3. Does the indicator assess sustainable forestry at the regional level? (Relevance to NA)
4. Is the indicator of unique/particular concern to the Northeastern Area? (Regional importance)
5. Does the indicator overlap with other indicators in the set?

Indicator Data/Measurement Questions

6. Is the indicator appropriate for data collection at the State level?
7. Is the indicator reliable? (Can you trust the information the indicator is providing?)
8. Can the indicator be feasibly collected?
   a. Is it costly or difficult? Does it require a special agency arrangement?
   b. Can it be measured over time or measured repeatedly?
   c. Can it be comparably collected across the 20 States?

Indicator Use Questions

9. Is the indicator useful to the intended audience? (Does it convey information that is meaningful to decision makers and/or the public, suitable for use across the 20 States and/or the region as a whole?)
10. Is the indicator relatively easy to analyze/interpret?
11. Is the indicator relatively easy to present and understand (for reporting to the general public)?

Northeastern Area. All indicators submitted were put into the first draft list of indicators, with little effort to condense those indicators that overlapped. This first draft list consisted of over 70 indicators. The work group met on a conference call to discuss how to proceed with the long list of indicators. In the next step, each work group member reviewed the combined list of indicators and individually identified no more than 15 top indicators. Each indicator chosen by one or more work group member was then compiled into the second draft list, resulting in roughly 35 potential draft indicators. The work group met during another conference call to further condense and narrow this list to 20 indicators. Although each indicator was not fully subjected to each indicator evaluation question by each work group member in this phase of the process, the indicator evaluation questions where considered when determining whether or not to drop an indicator from the list.

With the potential draft indicator list reduced to 20 indicators, the NFRPA/NA C&I project work group agreed to fully evaluate each indicator. Each work group member was asked to consistently evaluate the 20 indicators using an indicator evaluation matrix (figure 12), in which each indicator was evaluated according to 11 questions taken from the original list agreed upon in step 1 (box 7).

Figure 12. Portion of the indicator evaluation matrix used by the NFRPA/NA C&I project work group

	C & I Framework Questions					**Indicator Data / Measurement Questions**					**Indicator Use Questions**		
	Quest. #1	*Quest. #2*	*Quest. #3*	*Quest. #4*	*Quest. #5*	*Quest. #6*	*Quest. #7*	*Quest. #8*			*Quest. #9*	*Quest. #10*	*Quest. #11*
Ind. #	Relates to M.P. Criterion (list #):	Links to M.P. Indicator (list #):	Assesses forest sustain. at NA level (relevance)	Of unique / particular concern to NA	Overlaps w/ other indicators in the set (list #)	Approp. for data collection at state level	Is reliable (trust info. indicator provides)	Feasibly collected: **a.** Costly or difficult **b.** Measurable over time **c.** Can be comparably collected across NA states **a**	**b**	**c**	Useful to audience	Easy to analyze / interpret	Easy to present & under-stand
1													
Metrics:													
Comments:													
2													
Metrics:													
Comments:													
3													
Metrics:													
Comments:													

All indicator evaluations were compiled along with information about related Montreal Process indicators from the U.S. Roundtable on Sustainable Forests (U.S. Roundtable on Sustainable Forests 2001). Next, each work group member made recommendations for indicator revisions and the work group met again during a conference call to discuss the indicator evaluations and agree on proposed revisions. As a result, the 18 forest sustainability indicators listed in box 2 (page 5) were recommended as a base set of indicators for the Northeastern Area.

The NFRPA/NA C&I project work group considered potential indicator verifiers, including metrics and data sources for each indicator. In part, the group was able to utilize information provided by work group members through the indicator evaluation matrix. Draft copies of the forest sustainability assessment report for the Northern United States (USDA Forest Service 2001a) were also consulted and additional research done to determine relevant data and search out reliable data sources. The base NA forest sustainability indicators, along with the proposed metrics and data sources, are presented in appendix E.

APPENDIX E. PROPOSED METRICS AND THEIR DATA SOURCES FOR THE BASE SET OF FOREST SUSTAINABILITY INDICATORS FOR THE NORTHEASTERN AREA[1]

NA Base Indicator	Metrics	Data Source
Criterion 1—Conservation of Biological Diversity		
1. Area of forest land relative to nonforest land, area of timberland, and area of reserved land	Total land area (acres)	USDA FS FIA
	Total forest area (acres, acres per resident population ratio)	USDA FS FIA U.S. Census Bureau
	Forest as a percent of all land	USDA FS FIA
	Timberland area (acres, acres per resident population ratio)	USDA FS FIA U.S. Census Bureau
	Reserved forest land (acres, acres per resident population ratio)	USDA FS FIA U.S. Census Bureau
2. Extent of area by forest type and by size class, age class, and successional stage	Forest area by forest type (SAF forest types) (which includes successional stage)	USDA FS FIA and ECOMAP; Compared with U.S. NVC types
	Size class by forest type (acres by d.b.h. size class)	USDA FS FIA
	Age class by forest type (acres by years)	USDA FS FIA
3. Degree of forest land conversion, fragmentation, and parcelization	*Fragmentation*: Average patch size Amount of edge Inter-patch distance?	Remotely sensed analysis (forested vs. nonforested)
	Parcelization: Private forest landowner track size	USDA FS FIA landowner survey
4. Status of species and communities of concern with focus on forest associated species	Number of Federally listed forest associated species (by status and major taxa and relative to total)	USDI F&WS, Federal T&E database List of "forest occurring" species from U.S. Roundtable on Sustainable Forests
	Number of State listed species (by status and major taxa and relative to total)	State T&E species lists (need to be accessed individually)
	Number of U.S. NVC Globally Rare Communities (number by class and relative to total)	ABI; U.S. NVC; USDA FS ECOMAP
	Number of State rare forest and woodland communities (number and relative to total)	Natural Heritage Network and NatureServe

[1] See the acronym glossary following the table for definitions.

NA Base Indicator	Metrics	Data Source
Criterion 2—Maintenance of Productive Capacity of Forest Ecosystems		
5. Area of timberland	Timberland area (acres)	USDA FS FIA
	Forest land area (acres)	USDA FS FIA
6. Annual removal of wood products compared to net growth	Net growth to removal (ratio)	USDA FS FIA
Criterion 3—Maintenance of Forest Ecosystem Health and Vitality		
7. Area and percent of forest affected by damaging agents such as insects, disease, exotic/native species, fire, storm, land clearance, and domestic animals	Insects and diseases (including exotics) (acres/region)	USDA FS FHM
	Number and abundance of nonnative plant species and communities	USDA FS FHM
	Mortality (per acre)	USDA FS FIA
	Fire (occurrence, acres burned, severity, and ignition source)	National Interagency Fire Management Integrated Database
	Storm damage (wind, hurricane, ice, snow)	USDA FS FIA; NOAA; States
	Land use change (forest land conversion)	USDA NRCS
	Animal browsing, animal population statistics	USDA FS FIA; other USDA agencies; States
	Drought/flooding	USDA FS FIA; NOAA
Criterion 4—Conservation and Maintenance of Soil and Water Resources		
8. Status of species and communities of concern with focus on forest associated species	Soil erosion Diminished soil organic matter and/or change in other soil chemical properties Compaction and/or change in other soil physical properties resulting from human activities	USDA FS FHM

NA Base Indicator	Metrics	Data Source
9. Area and percent of forest land adjacent to surface water and area of forested land by watershed	Forest land adjacent to surface water (acres, percent, acres and percent by watershed)	Remote sensing analysis
	Forest land per watershed (percent) (use same HUC level that IWI uses to identify watershed) (acres, geographic distribution—map)	USGS HUD
10. The condition and vulnerability of aquatic systems by watershed	Index of Watershed Indicators (IWI)	U.S. EPA, Office of Water
Criterion 5—Maintenance of Forest Contribution to Global Carbon Cycles		
11. Total forest ecosystem biomass and carbon pool and contribution of forest ecosystems to the total carbon budget	Ecosystem biomass (tons)	USDA FS, U.S. Global Change Research Program
	Carbon pool (metric tons)	USDA FS, U.S. Global Change Research Program
	Carbon flux (metric tons/year)	USDA FS, U.S. Global Change Research Program
Criterion 6—Maintenance and Enhancement of Long-term Multiple Socio-economic Benefits to Meet the Needs of Societies		
12. Value and volume of wood and wood products production, consumption, imports, and exports	Production (value and volume by industry) Value added	USDA FS, Forest Products Lab; U.S. Census Bureau
	Consumption (value and volume)	USDA FS FIA, RPA Assessment
	Imports and exports (value and volume)	USDA FS FIA, RPA Assessment
	Degree of recycling (value and volume)	USDA FS, Forest Products Lab; AF&PA
13. Outdoor recreation activities and use, recreational facilities and use	Participants by activity Trips and days spent on different types of activities Expenditures by activity	USDI F&WS, National Survey of Fishing, Hunting, and Wildlife-Associated Recreation
	Trails (miles of type) Campgrounds	Survey of States; USDA FS NFS or other existing recreation data?

NA Base Indicator	Metrics	Data Source
14. Public and private investments in forest health, management, processing, manufacturing, and research	Manufacturing/processing investment (lumber, wood products, paper products)	AF&PA; U.S. Census Bureau
	Forestry program budgets	NASF State data
	State forestry statistics	NASF State data
	Forest land ownership: public, nonindustrial private, industrial private	USDA FS FIA
15. Public, private and industrial ownership and land use (including acres of specially designated land)	*The metrics listed for this indicator are not necessarily mutually exclusive; therefore, compilation and data manipulation is required to develop accurate summary statistics.*	
	Urban forest (acres)	USDA FS FIA
	National Forests and Parks (acres)	USDA FS NFS: USDI NPS
	State—forests, parks, wilderness areas (acres)	State forestry statistics
	Wild and Scenic Rivers	USDI NPS, National Wild and Scenic Rivers System
	Forest Legacy (acres)	USDA FS, Forest Legacy Program
	Wilderness Areas (acres)	National Wilderness Preservation System (USDI NPS, BLM, and F&WS; USDA FS)
	Research Natural Areas (acres)	USDA FS, RNA Program
	Biodiversity protection areas (acres)	Survey of States
	Old growth (definitions, acres)	State forestry statistics, other?
	Other conservation lands, etc. (acres)	TNC, Trust for Public Land
16. Trends in forest-related sectors' (e.g., wood products, recreation, and forest management) earnings and employment	Forest-related sectors (using NAICS codes) Earnings Employment State forestry personnel	U.S. Census Bureau; USDA FS IMI; IMPLAN; NASF forestry statistics

NA Base Indicator	Metrics	Data Source
Criterion 7—Legal, Institutional, and Economic Framework for Forest Conservation and Sustainable Management		
17. Existence, type, and monitoring of voluntary or mandatory best management practices	Existence of BMP's (yes/no)	Survey of States
	Type of BMP's (e.g., address soil, water, wetlands)	Survey of States
	Monitoring of BMP's (yes/no, type of monitoring)	Survey of States
18. Existence, type, and frequency of forest-related planning, assessment, and policy review, including cross-sectoral planning and coordination		Survey of States

Acronym Glossary

ABI Association for Biodiversity Information

AF&PA American Forest & Paper Association

BMP Best Management Practice

D.b.h. Diameter breast height

HUC Hydrologic Unit Codes (hierarchical watershed units)

IMPLAN IMpact analysis for PLANning

IWI Index of Watershed Indicators

NAICS North American Industry Classification System

NASF National Association of State Foresters

NOAA National Oceanic and Atmospheric Administration

RNA Research Natural Areas

RPA Forest and Rangeland Renewable Resources Planning Act

SAF Society of American Foresters

T&E Threatened and endangered

TNC The Nature Conservancy

U.S. EPA U.S. Environmental Protection Agency

USDA FS	U.S. Department of Agriculture, Forest Service
ECOMAP	Ecological Classification and Mapping
FHM	Forest Health Monitoring Program
FIA	Forest Inventory and Analysis Program
IMI	Inventory and Monitoring Institute
NFS	National Forest System
USDA NRCS	U.S. Department of Agriculture, Natural Resources Conservation Service
USDI	U.S. Department of the Interior
BLM	Bureau of Land Management
F&WS	Fish and Wildlife Service
NPS	National Park Service
USGS	U.S. Geological Survey
U.S. NVC	U.S. Natural Vegetation Classification

Appendix F. Survey of Data Availability at the State Level

As requested in the July 2001 NAASF motion [1], the NFRPA/NA C&I project work group developed a survey to conduct a preliminary assessment of data available at the State level. The purpose of the survey was to gather information on inventory and monitoring data that are not already collected or compiled at the regional or national level. This survey was a precursor to efforts to collect data that address the base set of NA indicators. At the July 2001 NAASF meeting, each State Forester also identified a State C&I contact person.

In developing the survey, the NFRPA/NA C&I project work group consulted previous data availability surveys conducted by the National Association of State Foresters and other groups. However, the survey was tailored to this particular project with specific questions pertaining to a number of NA base indicators (figure 13). The questions asked regarding each metric or indicator included the following:

- Do data provide statewide coverage?
- How accessible are these data and what effort is required to obtain them?
- Who is responsible for these data?
- General description of data, including units of measure and collection methods/protocols.
- How often are the data collected or updated?
- Format of the data (in some cases, whether GIS data is available).

Figure 13. Example page from the survey of data availability at the State level

Criterion 3: Maintenance of Forest Ecosystem Health and Vitality

NA Base Indicator #7. Area and percent of forest affected by damaging agents such as insects, disease, exotic/native species, fire, drought, storm, land clearance, and domestic animals.

a. Area and percent of forest affected by exotic/native species.
This is a measure of area and percent of forest where exotic/native pest species occur.
If necessary, photocopy this page and fill out one sheet per type of data.

Are state level data available for this metric? ☐ yes ☐ no

1. Do data provide statewide coverage?_____
2. Accessibility of these data to you & effort required to obtain it (check one):
   ☐High– You can easily access & obtain data. ☐Moderate– You can access data, but it takes some effort to obtain. ☐Limited– Data exists but there are serious impediments to obtaining it.
   If you checked moderate or limited accessibility, what are the barriers to obtaining these data?
3. Who is responsible for these data (agency, department, division etc.)?_____
4. General description of data, including key definitions, classification system, units of measure, & collection methods/protocols:_____
5. How often are data collected or updated?_____
6. Dates data are available for (how far back data goes):_____
7. Format of data: ☐paper or ☐electronic, file type (e.g., MS Excel):_____
   Are these data available digitally for use in a Geographic Information System (GIS)? ☐yes ☐no
8. Are the inventory or monitoring methods used to gather the data consistent across the state?_____
   Have the methods been consistent over time?_____
9. How are the data sets documented?_____
10. Overall quality of data (circle one):
    Poor----------High
    1 2 3 4
    Please comment on your reason for this ranking (ie., it is due to data consistency, its accuracy, precision, completeness, reliability, etc.):
11. Data available on a web site: ☐none ☐raw data ☐data summaries
    The web address:_____
12. Additional comments:_____

Feel free to attach sheets with additional information as necessary. 3

[1] See appendix C for the full July 2001 NAASF Motion.

- Are the inventory or monitoring methods consistent across the State?
- Have the methods been consistent over time?
- How well are the data sets documented?
- Overall quality of data on a scale of 1 to 4 and comments on reason for this ranking.
- Whether data are available on a Web site.

Respondents were not limited to data available from the State forestry agency; they were encouraged to include data available from other State agencies and organizations.

At the time this sourcebook was completed, the NFRPA/NA C&I project work group had compiled the results of the survey into a database and begun analysis, focusing on data availability. This analysis will also involve researching potential data sources and examining consistency across the 20 States, allowing the work group to determine which indicators can be measured using State level data.

APPENDIX G. DEVELOPMENT OF SUSTAINABILITY/ INDICATORS EFFORTS DATABASE AND INDICATORS DATABASE

The evaluation of existing sustainability/indicators efforts included the development of a database that contains descriptive information about 60 sustainability/indicators efforts and a database that contains 39 different sets of sustainability or environmental indicators.

The databases were developed in response to requests from the Northeastern Area Association of State Foresters (NAASF) to provide information about current sustainability/ indicators initiatives. This project was carried out by the Northeastern Area (NA) in collaboration with the Northeastern Forest Resource Planners Association (NFRPA). Initial database development was conducted from March to July 2000. Further development and analysis continued from July 2000 to the present. The results presented in this document represent analysis of the databases as of June 2001. The databases are periodically updated to include additional projects and to update information as efforts evolve.

Various methods were used to obtain information about sustainability/indicators efforts. Contacts and requests for information were made by E-mail and phone, directly contacting the lead agency or organization for the effort. Significant research was also conducted via the Internet. In some cases, initial information about various efforts was received by word-of-mouth and then verified. In other cases, communication was made with key contacts within State forestry and other natural resource agencies to learn of efforts that are relevant to include in the database. For database entry, information was taken as cited, where possible. Sixty sustainability/indicators efforts were entered into the database (box 8).

Box 8. Sixty sustainability/indicators efforts are contained in the database

International Efforts
International Arrangement on Forests—United Nations Forum on Forests
The World Commission on Forests and Sustainable Development
Montreal Process Working Group
Forest Stewardship Council (FSC)

National Efforts
Sustainable Forestry Partnership
President's Council on Sustainable Development
Sustainable Forestry Initiative (SFI) Program
State of the Science Ecological Indicators Report
U.S. Interagency Working Group on Sustainable Development Indicators
U.S. First Approximation Report
Report on the State of the Nation's Ecosystems
National Association of State Foresters Sustainable Forestry Implementation Committee
National Association of State Foresters First Approximation Assessment Project
National Environmental Performance Partnership System
U.S. Roundtable on Sustainable Forests

Regional (Multistate) Efforts
New England Goals and Indicators Project/Partnership
Forest Sustainability Assessment Report for the Northern United States
Chesapeake Bay Program
Trends in Sustainability Indicators Project
Selection of Indicators for Great Lakes Basin Ecosystem
Northern Forest Lands Council
Great Lakes Forest Alliance Sustainable Forest Management C&I Project
Ecosystem Indicators and Targets for Lake Superior
Lake Superior Lakewide Management Plan
Vital Communities of the Upper Valley
Northern Forest Wealth Index
Mid-Atlantic Integrated Assessment (MAIA)
Narragansett Bay Estuary Program

State Efforts
Environmental Quality in Connecticut
Illinois Environmental Conditions and PPA*
Illinois Critical Trends Assessment Program (CTAP)
Illinois Report on Sustainable Forest Management
Maryland's Environmental Indicators/PPA*
Maryland's Strategic Forest Lands Assessment
Maine Measures of Growth 2000
Maine Forest Sustainability Standards
Minnesota Milestones
Minnesota Sustainable Development Initiative
Minnesota's Sustainable Forests Program
Minnesota Environmental Indicators Initiative (EII)
Missouri Resource Assessment Partnership (MoRAP)
New Hampshire Forest Sustainability Standards Work Team
New Hampshire Comparative Risk Project
New Jersey Future
New Jersey Environmental Indicators and PPA*
Ohio Comparative Risk Project
Oregon Forest Assessment Projects
Sustaining Penn's Woods
Vermont Forest Resources Plan
Vermont Strategic Plan and Agency of Natural Resources Indicators
Vermont Monitoring Cooperative (VMC)
Wisconsin Northern State Forest Assessments
Wisconsin Department of Natural Resources Performance Measures Effort

Forest Management Unit Efforts
North American Test of C&I of Sustainable Forestry
Lake Superior State Forest Sustainable Forest Management Project
Local Unit Criteria & Indicators Development Project (LUCID)

City and County Efforts
Sustainable Boston
Sustainable Lansing Project
Cape Cod Sustainability Indicators Project
Northern New England Sustainable Communities Implementation Project-Franklin Co.

* PPA–Performance Partnership Agreement; involvement in the U.S. EPA National Environmental Performance Partnership System